Iron AND Steel ENGINEER

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MARCH, 1957

TECHNOLOGY DEPT.

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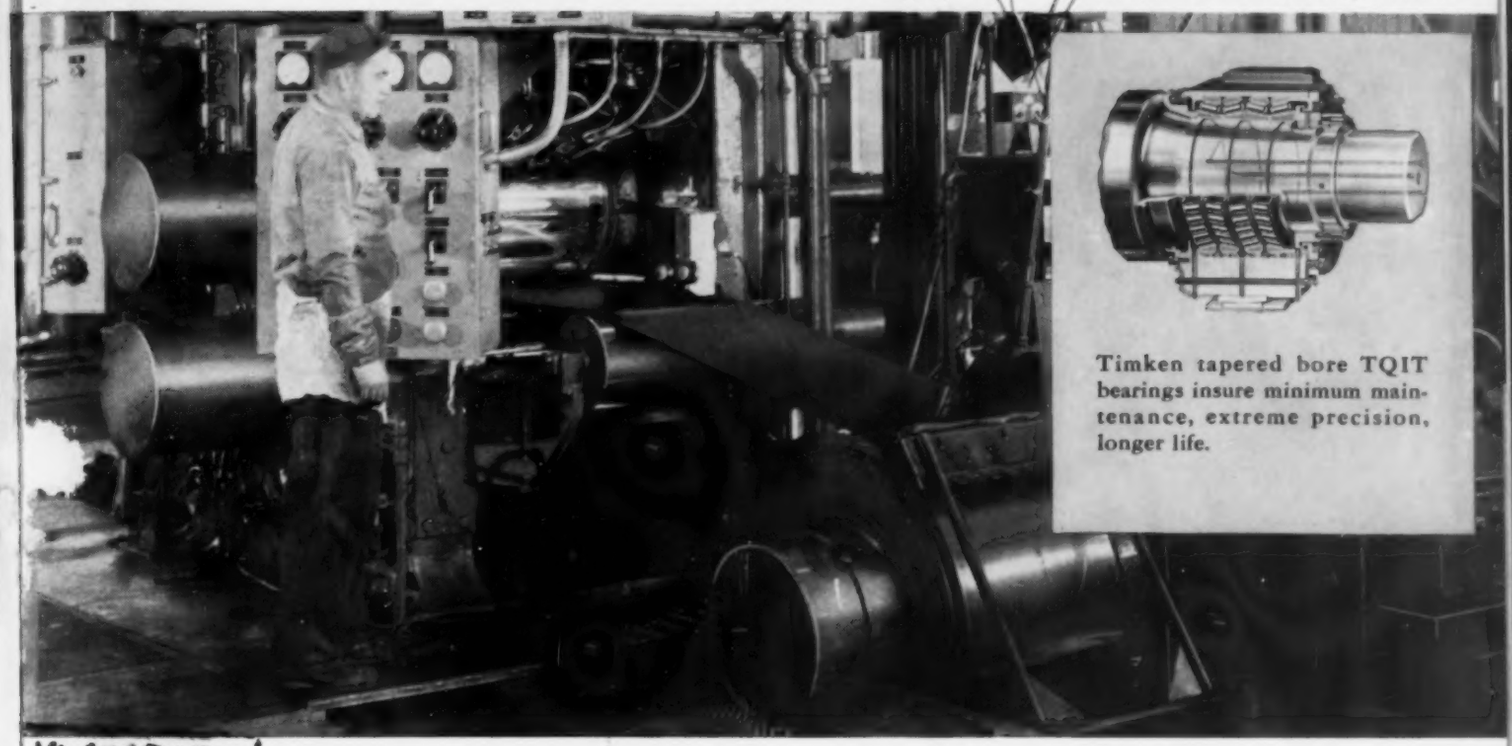

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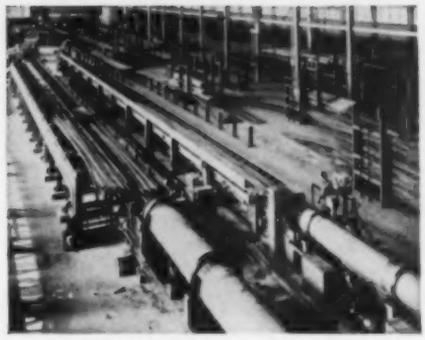

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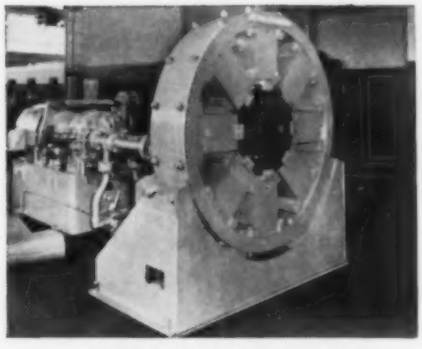

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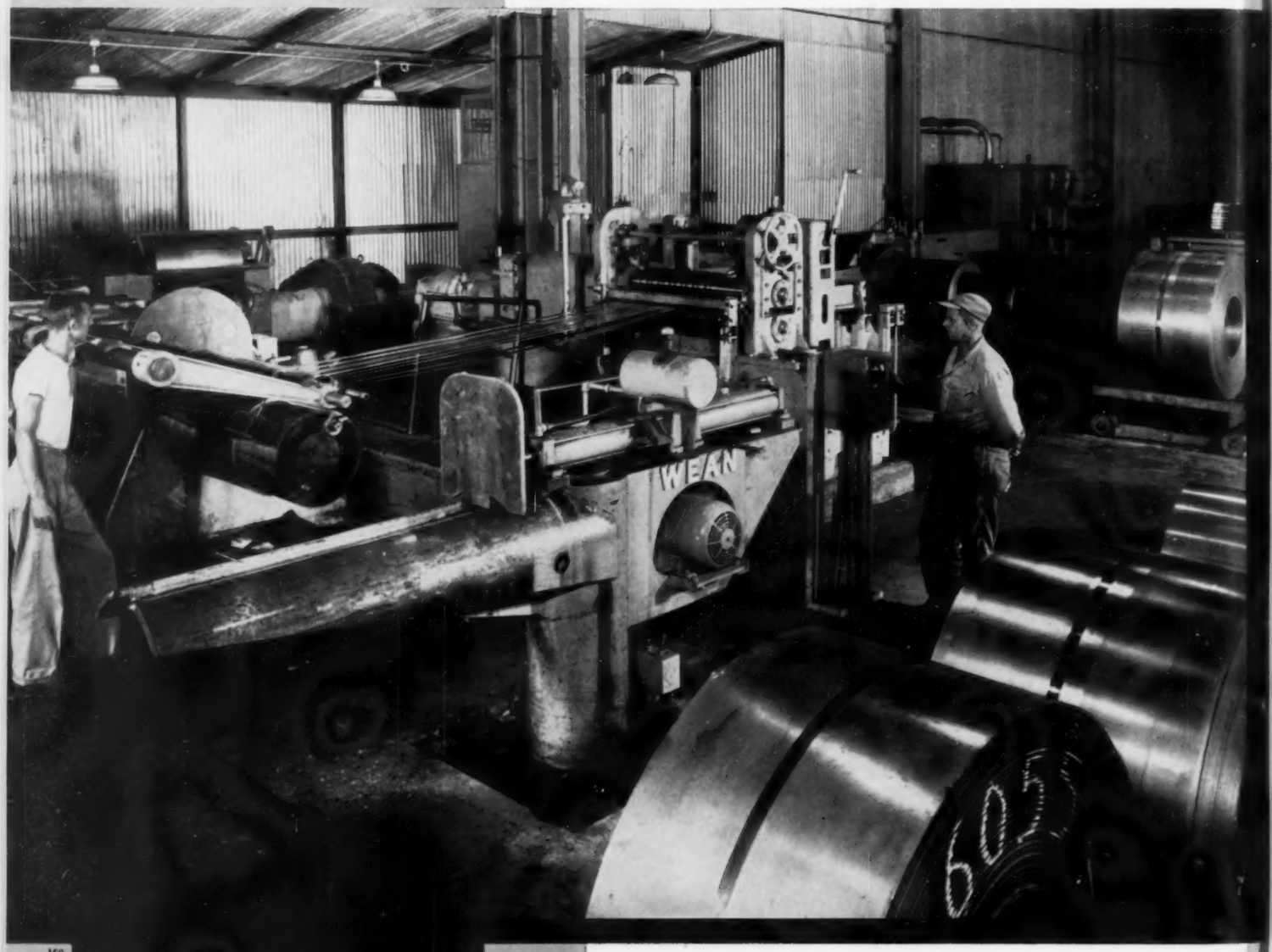

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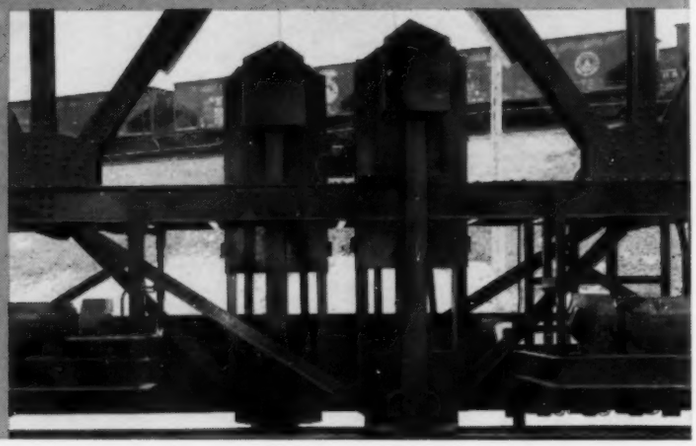

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See what modernizing with BLISS equipment has done for American Brass' Kenosha Division!

Limit on bar weight raised to 3000 pounds! Before the addition of Bliss entry and delivery equipment, 800-pound bar was the heaviest practical weight that could be put through this single-stand one-way breakdown mill, which reduces the ½-inch copper or brass in a series of passes. The new handling equipment readily coils 3000-pound weights of metal and transfers them gently back to the entry side. Similar Bliss equipment is used with a second single-stand mill, which takes the strip to 0.050-inch gage.

One-way mills converted to reversing! Production of larger coil sizes justified the conversion of one-way mills to reverse rolling operations. Bliss handling equipment has made the work easier and safer for the operating and servicing personnel.

1800 fpm. of new finishing capacity added! This brand new Bliss 5-stand 4-high tandem mill reduces the 0.020-inch strip to gages as thin as 0.004-inch in a single pass. It can deliver 1800 feet per minute of half-width strip. According to the Kenosha Division, it is one of the few 5-stand tandem mills in the brass industry, and the most advanced unit for the finish rolling of metal to exacting specifications for gage. Bliss coil buggy, belt wrapper and tension reel handle coils from 6 to 10 inches wide, up to 27 inches O.D. and 1600-pound maximum weights.

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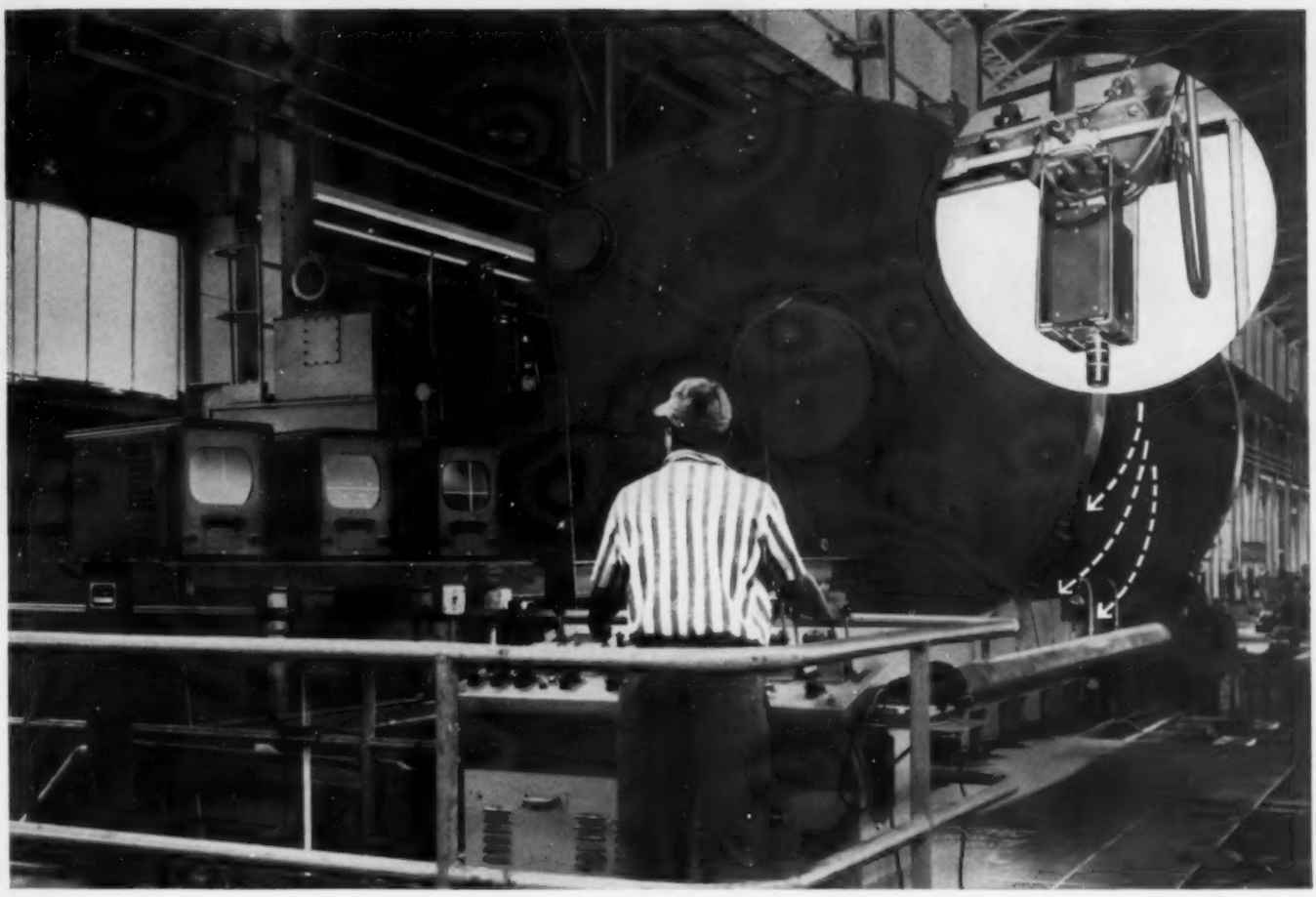

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With RCA Industrial TV to guide him, one man at Lukens Steel Company controls this huge 800-ton plate shear although he cannot see the actual operation! Three RCA TV cameras installed above the blade are connected to three monitors located at the control position. Watching the monitors, the operator moves heavy plate into the shear, lines up the plate with a guide wire, and accurately trims it to size . . . all by remote control!

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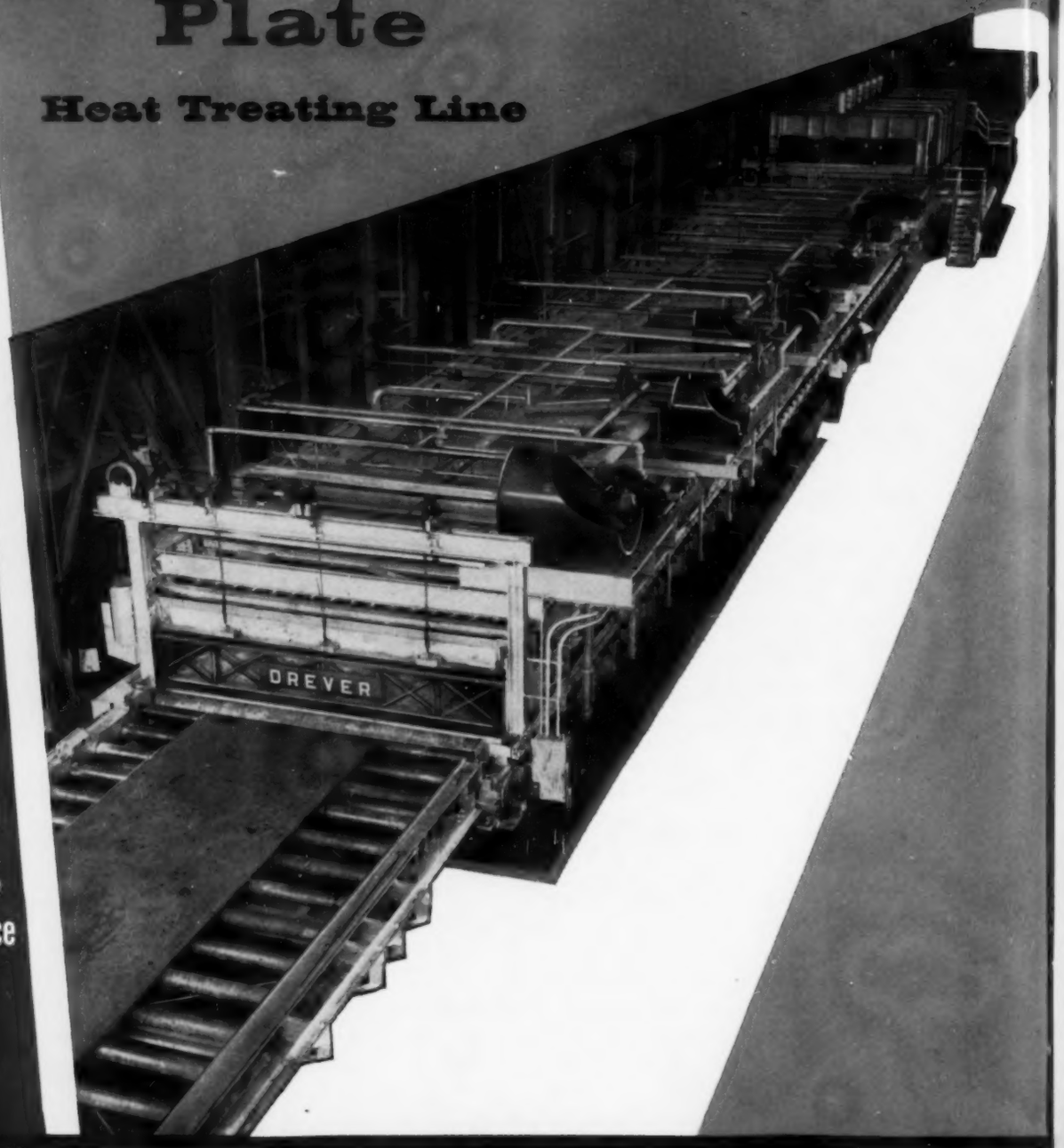

Shown is the charging end of a 145'-0" hardening furnace. In the background can be seen a 2500 ton pressure quench, 200'-0" draw furnace and the operator's control pulpit.

This roller-hearth plate heat treating line, known to be the largest of its type, has a capacity to treat plate up to 21-1/2 tons per hour. The equipment is capable of handling plate sizes up to 172" wide x 3" thick x 600" long.

The furnace rolls are 35/12 modified alloy and are designed for a maximum furnace operating temperature of 1650° F.

The maximum fuel capacity for both furnaces is 122,000,000 Btu's per hour.

The entire line is under the control of a single operator. Full utilization of strategically located TV cameras enables the operator to have full control over all operations.

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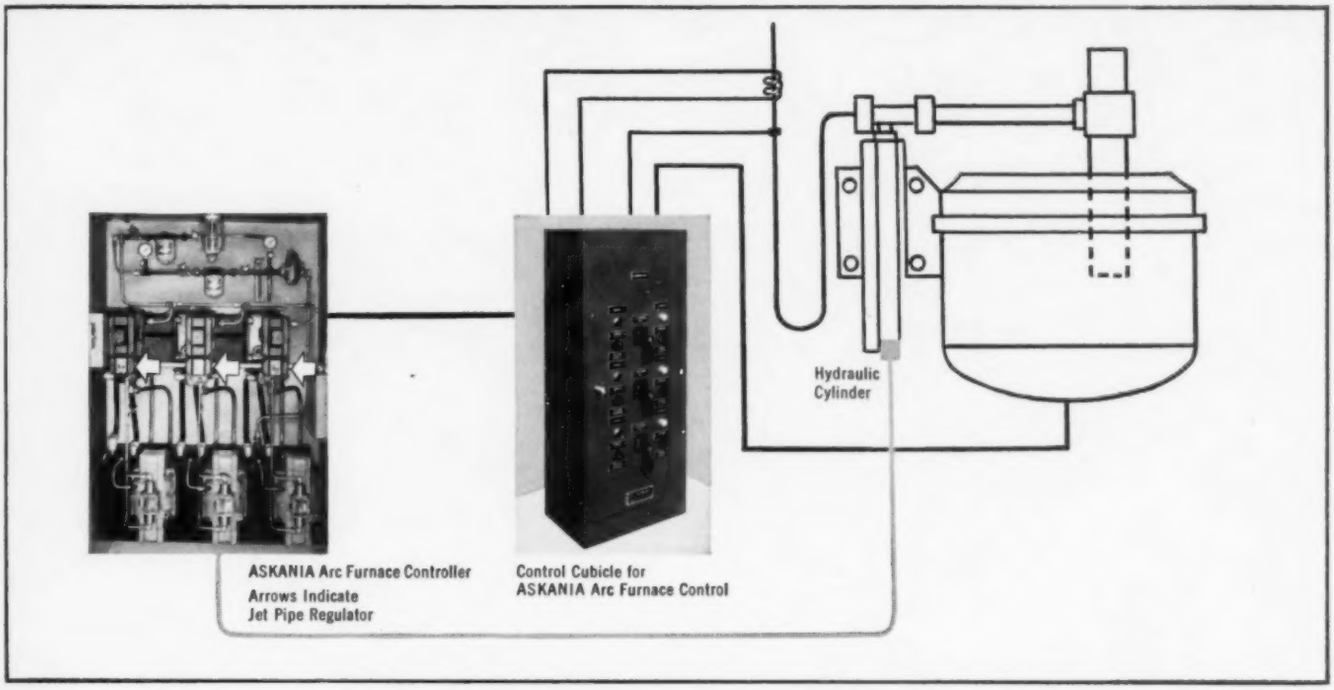
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2 • *ACCURATE*—High force inertia ratio of hydraulic motor (piston) *permits high performance without overshooting.*

3 • *DEPENDABLE*—Proven ASKANIA design reduces number of moving parts. Self-lubricating, it may be operated in most unfavorable atmospheric and temperature conditions *without expensive and space consuming protective shelters.*

4 • *EASILY, INEXPENSIVELY MAINTAINED*—The force balance system contains only one moving part in the regulator (the Jet-Pipe Relay). Even after periodic inspection is made factory calibration is easily maintained after reassembly.

5 • *PEAK PERFORMANCE*

—Advanced signal system reduces mass and consequently inertia to further improve performance.

New Descriptive Bulletin Provides Complete Information

The new ASKANIA REGULATOR Bulletin #33.2 fully describes the ASKANIA Arc Furnace Control...what it is...how it works... where it is applied...how it is maintained...the advantages it brings to arc furnace operation. Write for your copy to Askania Regulator Company, 246 E. Ontario Street, Chicago 11, Illinois.

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THE new federal budget, totaling $71,800,000,000, disappointed a great many people in the United States who have been hoping for a reduction in government spending. It amounts to $417 per capita for the 172,000,000 population expected by next January. Four years ago it was $394 per capita—and 30 years ago it was $25.

If we add state and local governments and the various trust funds which do not show on the budget, total taxes approach one-third of the national income.

Recommendations of the Hoover Commission pointed out potential annual savings of $5,500,000,000. Less than 10 per cent of this amount has been saved by carrying out some of the less controversial reforms.

On the other hand, federal grants have furnished 8 to 10 per cent of state and local revenues, and states in turn are giving money to local governments. Such grants are not gifts but only the return of some of our tax money minus heavy administration costs. They are temptations to extravagance. There is no doubt that waste increases with the distance separating the taxer and the spender. Local governments, who now say "If we don't spend it, someone else will," would look twice if they had to raise the money to pay for their projects.

Someone, sometime, somehow, must put on the brakes. Maybe that someone is you and I and a lot of others who ought to shed their apathy and demand action.

▲

REPORTS of 1956 earnings by steel companies look good despite the strike which crippled third-quarter operations. Among major producers, about two out of three reported higher figures in 1956 than in 1955. Several companies hit records in both sales and earnings.

▲

ACCORDING to the American Iron & Steel Institute, the industry's payroll for 1956 was a record $3,795,975,000. Hourly payroll cost for wage earners averaged $2.70 for the year, not including about 25 cents per hour for pensions, social security and insurance.

For the year, the industry's total employment was estimated at 653,400.

▲

SOME spokesmen for the electrical utilities predict a doubling of load every ten years. The Federal Power Commission is somewhat less optimistic, but predict installed generating capacity as follows:

	Million kw
1960	161
1965	210
1970	263
1975	321
1980	386

That's still a good growth.

▲

GOVERNMENT turndown of rapid amortization for steel plant projects makes expansion financing difficult. Higher steel prices are almost a certainty, particularly when wages go up in July as set up by the steel labor contract.

Ordinary depreciation in the steel industry is about $400,000,000 a year, whereas $1,000,000,000 a year is needed to maintain capacity at its present level. Without rapid amortization, the difference must be made up from retained earnings.

▲

A FORECAST from National Securities & Research Corporation expects plant and equipment outlays by business in 1957 to set a new record at $37,500,000,000, public and private construction to hit $46,500,000,000, also a record, and gross national product to rise to $430,000,000,000.

▲

TEN steel companies make up about 80 per cent of the new capacity of the United States:

	Tons per year
Armco Steel Corp.	5,950,000
Colorado Fuel & Iron Corp.	2,830,000
Youngstown Sheet & Tube Co.	6,240,000
Republic Steel Corp.	11,047,000
Jones & Laughlin Steel Corp.	6,600,000
Inland Steel Co.	5,500,000
National Steel Corp.	6,200,000
Wheeling Steel Corp.	2,200,000
Bethlehem Steel Co.	20,500,000
United States Steel Corp.	39,582,000

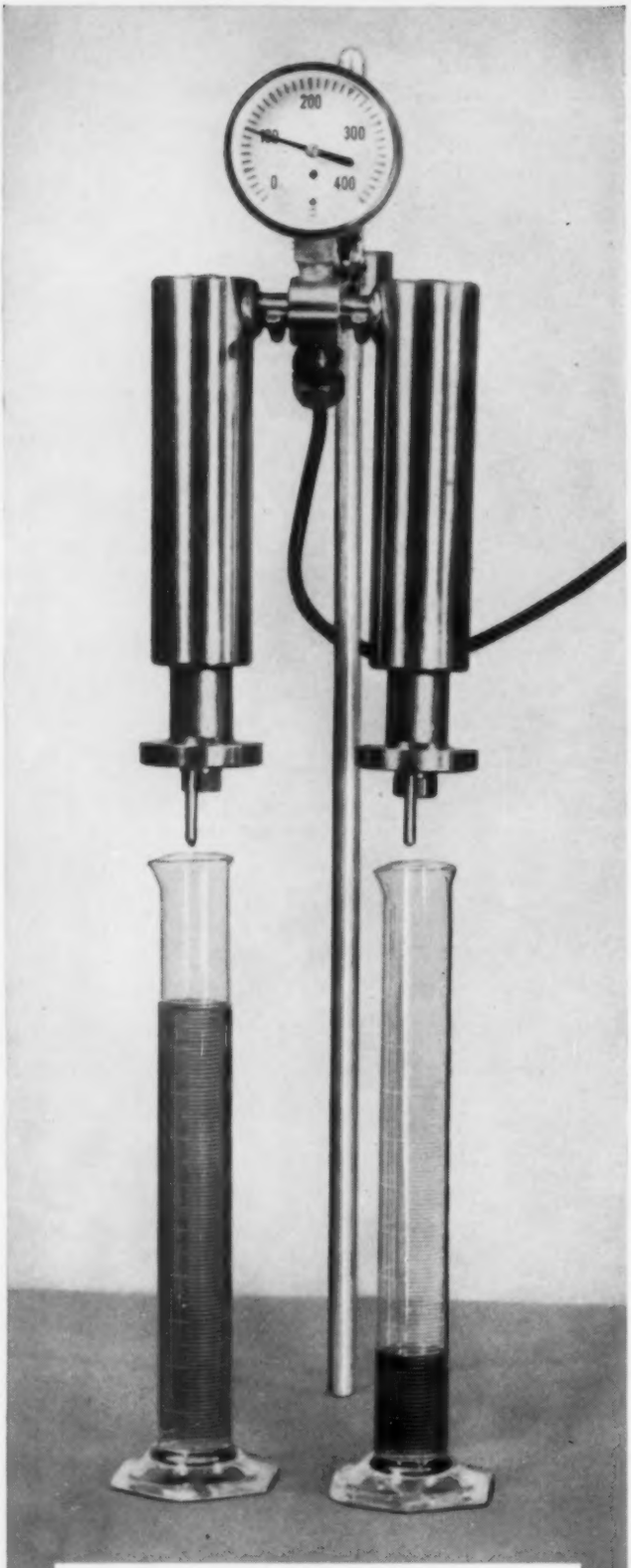
▲

IN spite of the steel strike, production of stainless steel set a record of 1,210,569 tons in 1956. Chromium-nickel types showed an increase, forming 61.2 per cent of the total, but in these types, the low-nickel types showed a substantial increase.

▲

ACCORDING to a long-term economic forecast made by Lukens Steel Co., there will be no major depression over the next 20 years. Among the conclusions of the study:

1. Total output of goods and services will increase approximately 11 per cent annually over the next 20 years.
2. Industrial production will increase 5 per cent annually.
3. The general price level will continue to move upward—probably 3 per cent per year.
4. Total steel production will increase at an average annual rate of about 4 per cent.



Less oil loss with Suntac is proved by this leakage demonstrator. Suntac oil is placed in one chamber, a straight mineral oil of the same viscosity in the other. Both oils are pressured through sintered bronze bearings. At 100 psi the straight mineral oil leaks out four times faster than Suntac.

LEAKAGE DEMONSTRATOR PROVES SUNTAC CAN CUT OIL LOSS AS MUCH AS 75%

Expensive equipment overhauls to stop leaks in hydraulic systems can often be avoided by a change to Suntac®. The exceptional antileak characteristics of Suntac oils can reduce oil losses as much as 75%, as can be proved in the leakage demonstrator. *Some users have reported actual drops in oil leakage of 90%.*

Suntac oils give you lower lubrication costs, cleaner equipment and floors, safer working conditions. Their leak-reducing agent leaves no gummy film or residue. In addition, Suntac oils are fortified against oxidation to lengthen oil life...against rust and corrosion to lengthen equipment life.

You'll find Suntac a money and time saver in your hydraulic systems...and a high-quality general-purpose oil for many other uses.

WANT MORE SUNTAC FACTS? Ask your Sun representative for Technical Bulletin 23. Or you can get full details, prices, and delivery information by writing to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. IS-3.

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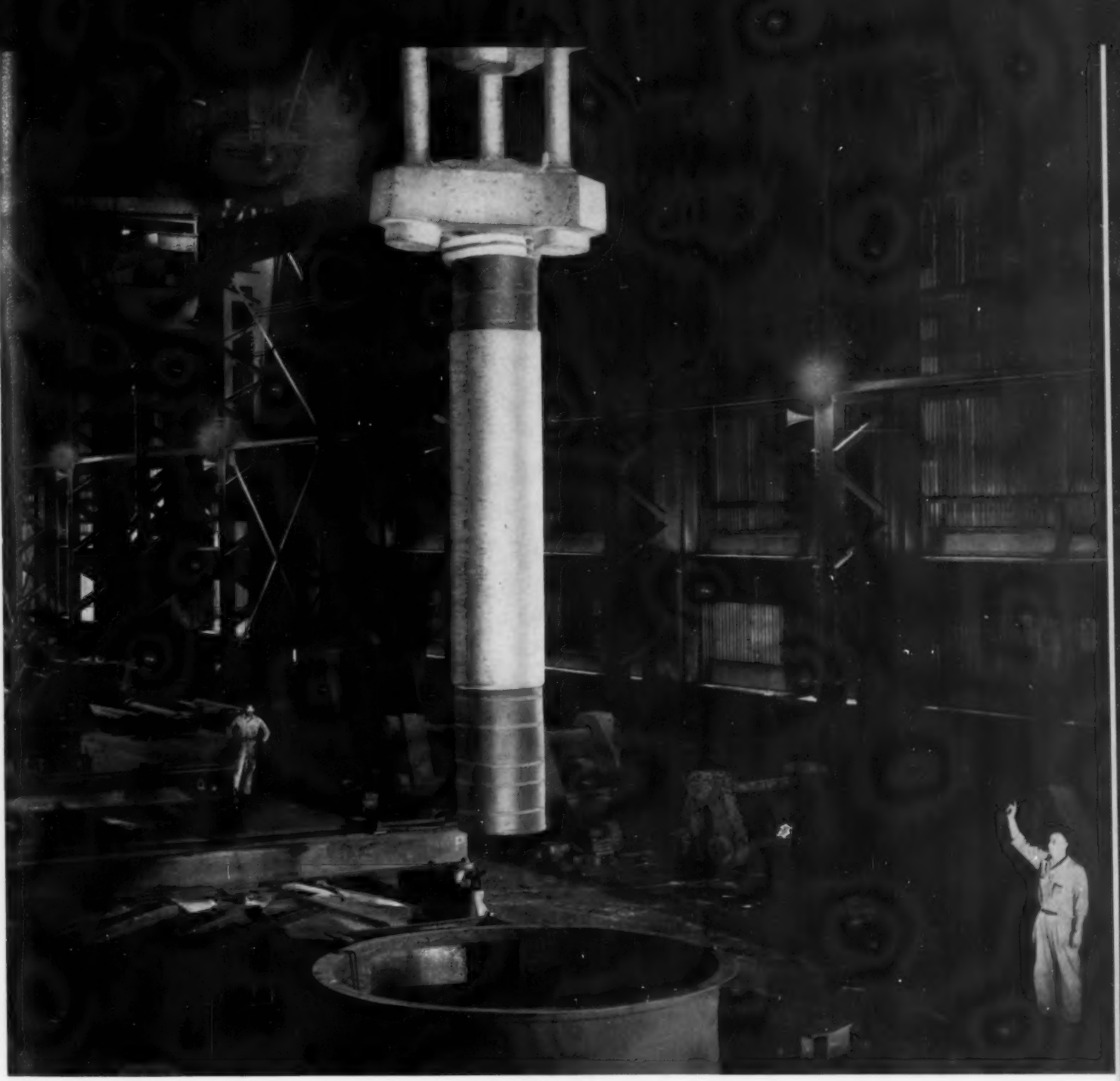
Philadelphia 3, Pa.

In Canada: Sun Oil Company Limited, Toronto & Montreal



12-Ton Roll Poised for a Bath

A moment after this photograph was taken, the big heated forging was lowered into the quenching tank. Temperature of the forging and period of immersion were of course closely controlled; the forging was a steel roll in the making, and every operation had to be handled with the utmost precision.

When finished and shipped from the Bethlehem plant, the roll weighed an even 12 tons. Its overall length was approximately 17 ft; body diameter was 28 in. The purchaser ordered it to his own specifications for use in rolling aluminum.

Rolls like this require the most painstaking care, and at Bethlehem they get it. The strictest metallurgical controls are enforced at every step, beginning with the making of the steel. When a roll leaves our shops, it meets all specifications on size, finish, hardness, down to the last detail.

Bethlehem forged rolls are completely dependable for cold-rolling ferrous sheets and strip; running-down and finishing operations on copper and brass sheets; hot- and cold-rolling aluminum sheets; cold-rolling aluminum foil. Call us when we can be of service; our engineers will gladly cooperate.

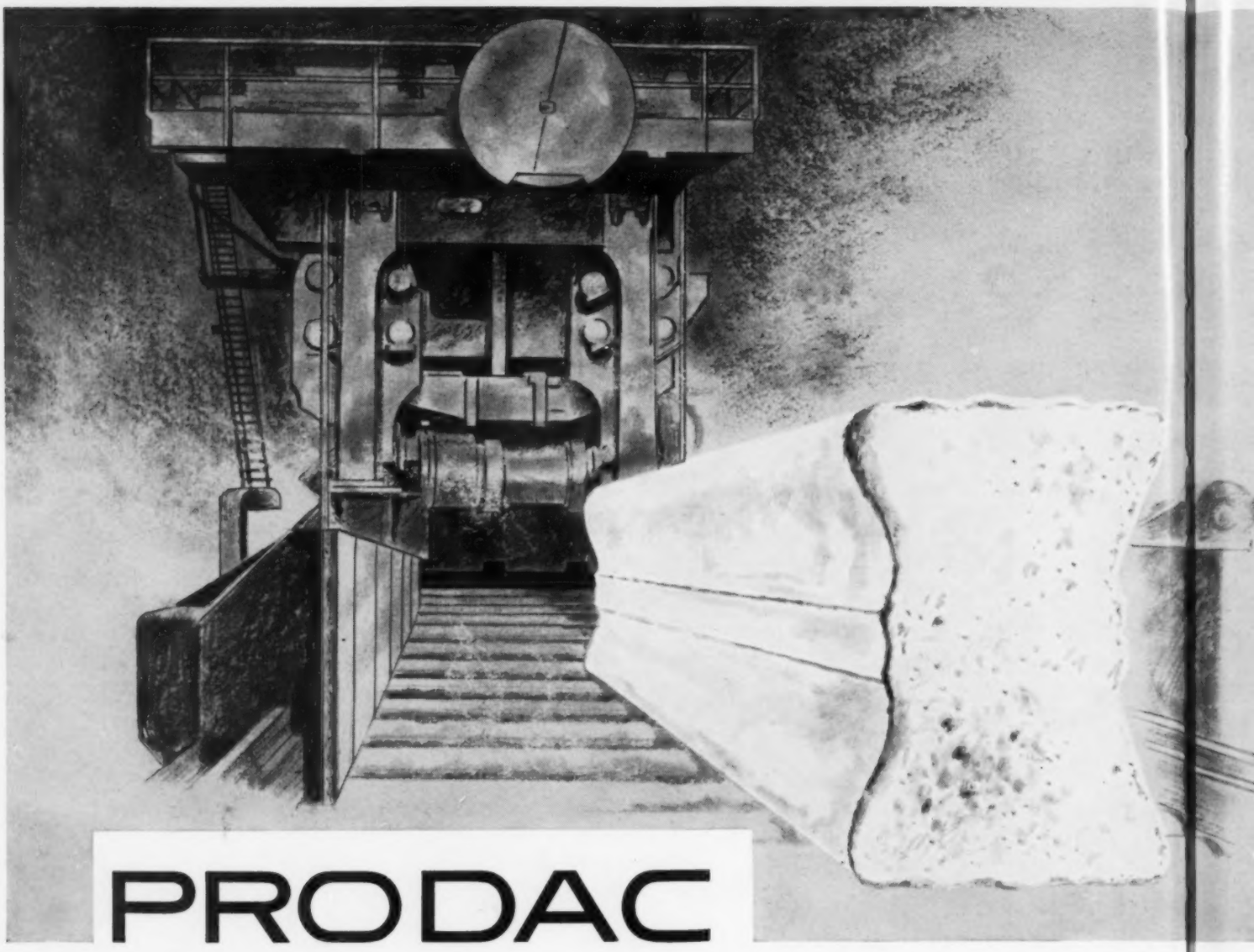
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL



PRODAC

PROGRAMMED DIGITAL AUTOMATIC CONTROL

a revolutionary new steel mill control by Westinghouse

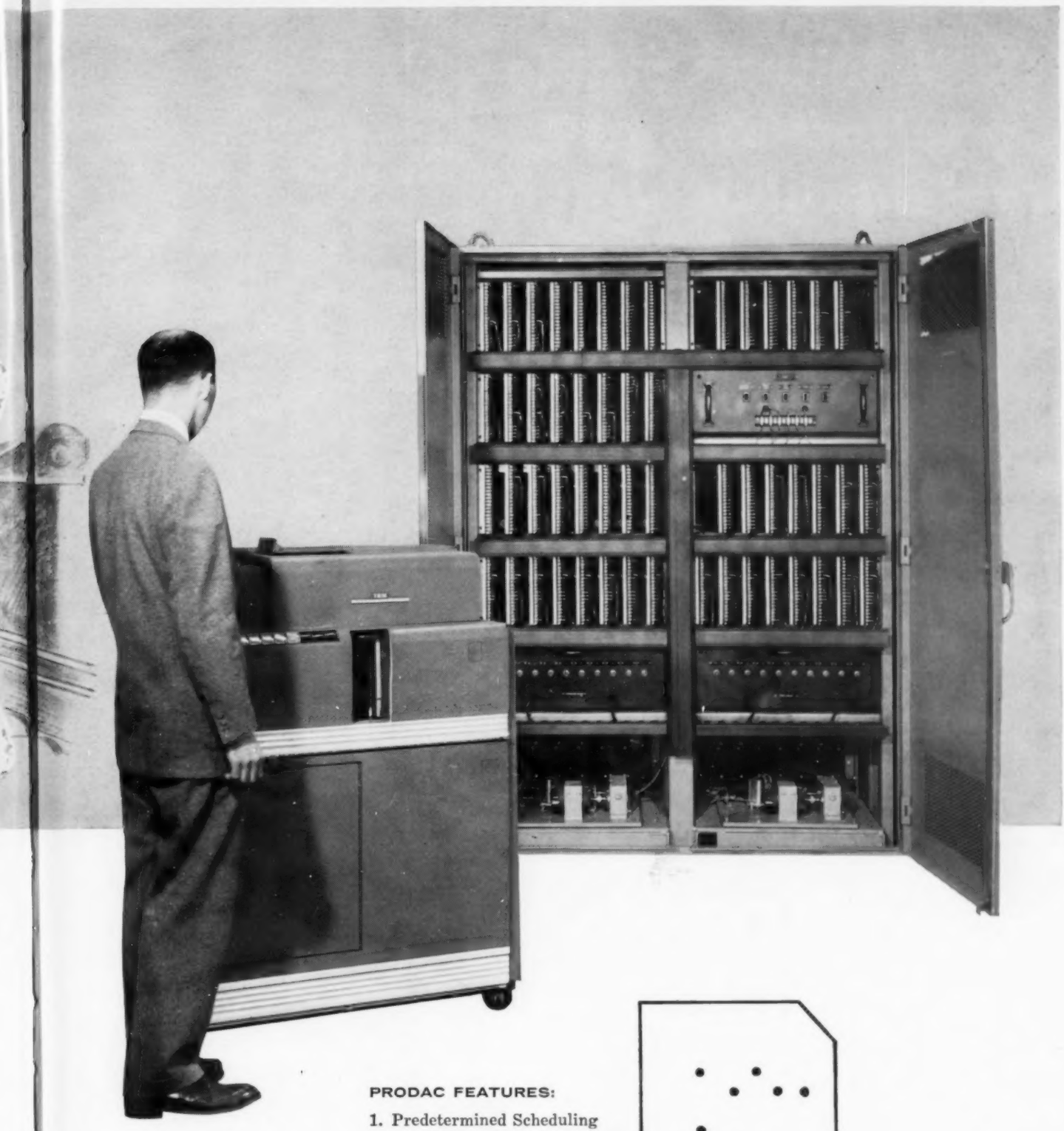
With Westinghouse PRODAC*, the full capacity of mill equipment can be utilized. This revolutionary new mill control now makes possible a consistent capacity production rate with positive accuracy in operation.

Through the card programmed system, mill operation is completely predetermined. To initiate a rolling schedule, the operator just feeds in the pre-punched "reader" cards. He then pushes a button, and the control automatically runs the mill, makes the necessary number of passes, and provides continuing adjustment of mill speed and screwdown opening.

To find out how Westinghouse Systems Control Engineering can apply PRODAC to your mill operation, call your Westinghouse representative. Or, write Westinghouse Electric Corporation, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

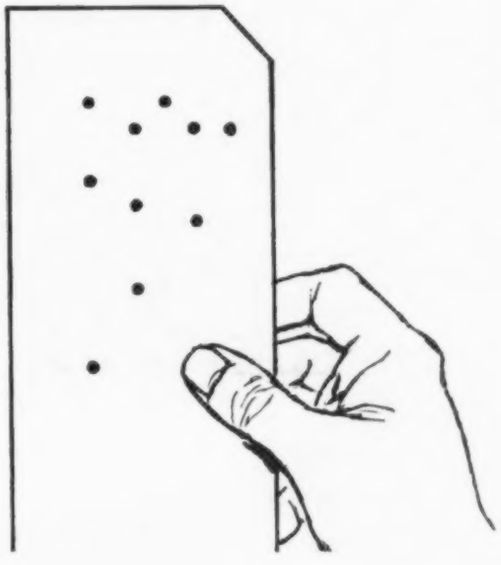
J-22006
*Trademark

YOU CAN BE SURE...IF IT'S Westinghouse



PRODAC FEATURES:

1. Predetermined Scheduling
2. Digital Representation and Treatment of Data
3. Punched Cards
4. Transistor Circuitry
5. MAGAMP* Regulators
6. Ultimate Control of Adjustable-Voltage Drives

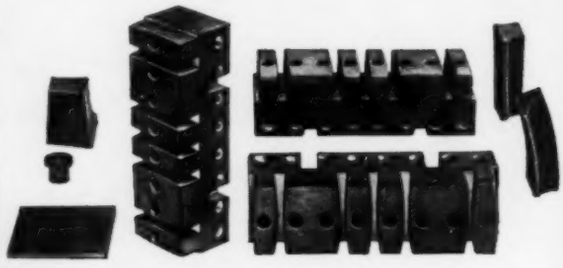


B&W Silicon Carbide Refractories for metal-working furnaces

To meet the specialized requirements of the primary metals industry, B&W manufactures Silicon Carbide Refractories in a variety of shapes and sizes. These durable refractories are produced in B&W's Augusta, Ga., works to the same rigid quality control standards used in making all B&W Refractories. See your local B&W Refractories Engineer for further information.

B&W Silicon Carbide Rolls

B&W Silicon Carbide Recuperator Tubes



B&W Silicon Carbide Special Shapes

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Wheelabrator mechanical descaler for cleaning skelp.

Another example of Steel Industry Savings with Wheelabrator® Mechanical Descaling

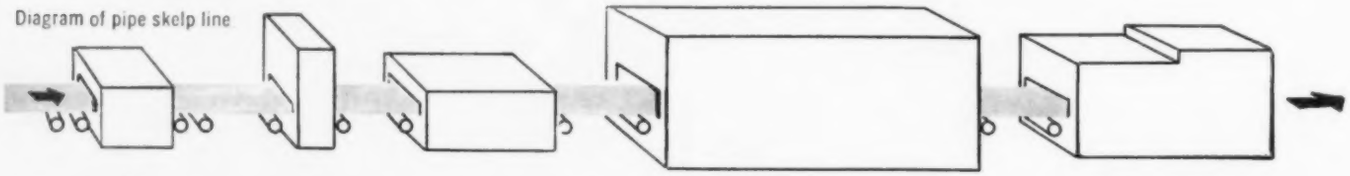
Wheelabrator mechanical descaling equipment, now being used to clean pipe skelp edges, serves to underline the versatility this process holds for the steel industry and shows the high degree of control that can be achieved.

In preparing pipe skelp for electrowelding, only a small strip along either edge of the bottom side of the skelp must be cleaned to bare virgin metal to the copper electrodes. Finish on the surface of the pipe, of course, is not critical.

In Wheelabrator equipment, a blasting wheel is positioned under each edge of the skelp so that the blast pattern is parallel with the length of the skelp. As skelp passes through the Wheelabrator there is fast, thorough cleaning of edges without wasting power or abrasive on areas that do not need to be cleaned.

For information on savings you can **make with** Wheelabrator equipment in all phases of steel descaling, write today for your copy of Bulletin 128-D.

Diagram of pipe skelp line



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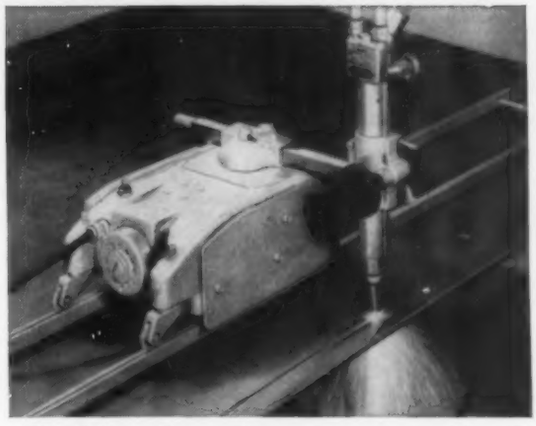
Machine-Cutting Clears the Way to $13,000 Savings

One steel company is saving up to $13,000 a year by using oxygen shape-cutting machines for making ingot and pan links from steel plate.

Previously these parts were forged at an annual cost of approximately $30,000. The speed and accuracy of oxygen shape-cutting cut costs to $17,000 a year—a savings of more than two dollars on each of the 5,000 parts made.

Machine-cutting setups are speeding fabrication and cutting costs throughout industry. Whatever your part-producing needs are—cutting hundreds of parts at one time, or one-of-a-kind turnout—there are LINDE oxygen shape-cutting machines to help you save hours and dollars in production time.

LINDE service engineers will be glad to help you determine the shape-cutting setup to best serve your job needs. Call your local LINDE representative for more information. Start saving now—call him today.



This lightweight portable cutting machine weighs only 38-lbs., and can cut metals up to 10-in. thick. It can cut straight lines, circles, and plate edge preparations in from 4-in. to 32-in. per minute.

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A Division of Union Carbide and Carbon Corporation
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Division of Union Carbide Canada Limited, Toronto
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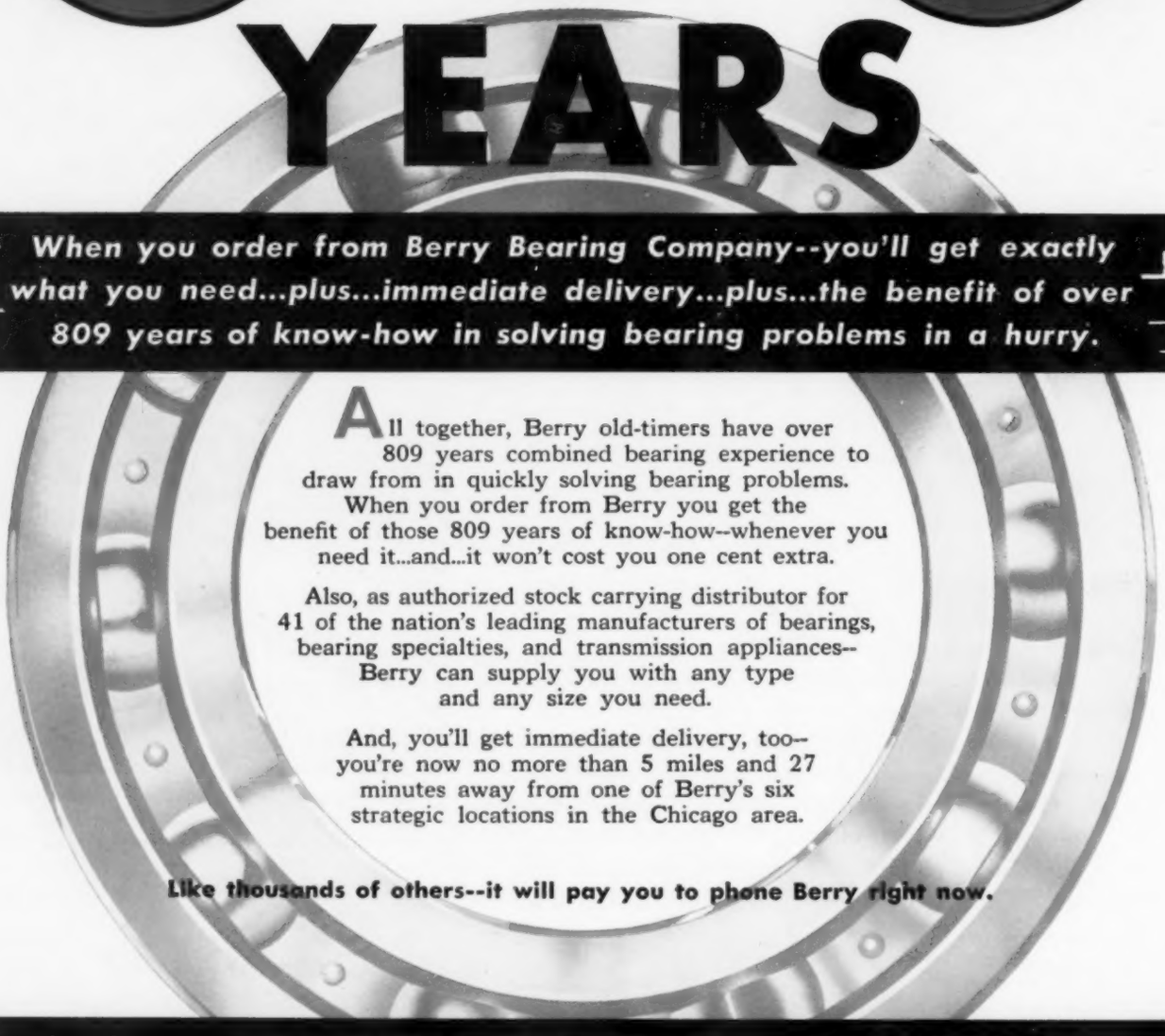
When you order from Berry Bearing Company--you'll get exactly what you need...plus...immediate delivery...plus...the benefit of over 809 years of know-how in solving bearing problems in a hurry.



All together, Berry old-timers have over 809 years combined bearing experience to draw from in quickly solving bearing problems. When you order from Berry you get the benefit of those 809 years of know-how--whenever you need it...and...it won't cost you one cent extra.

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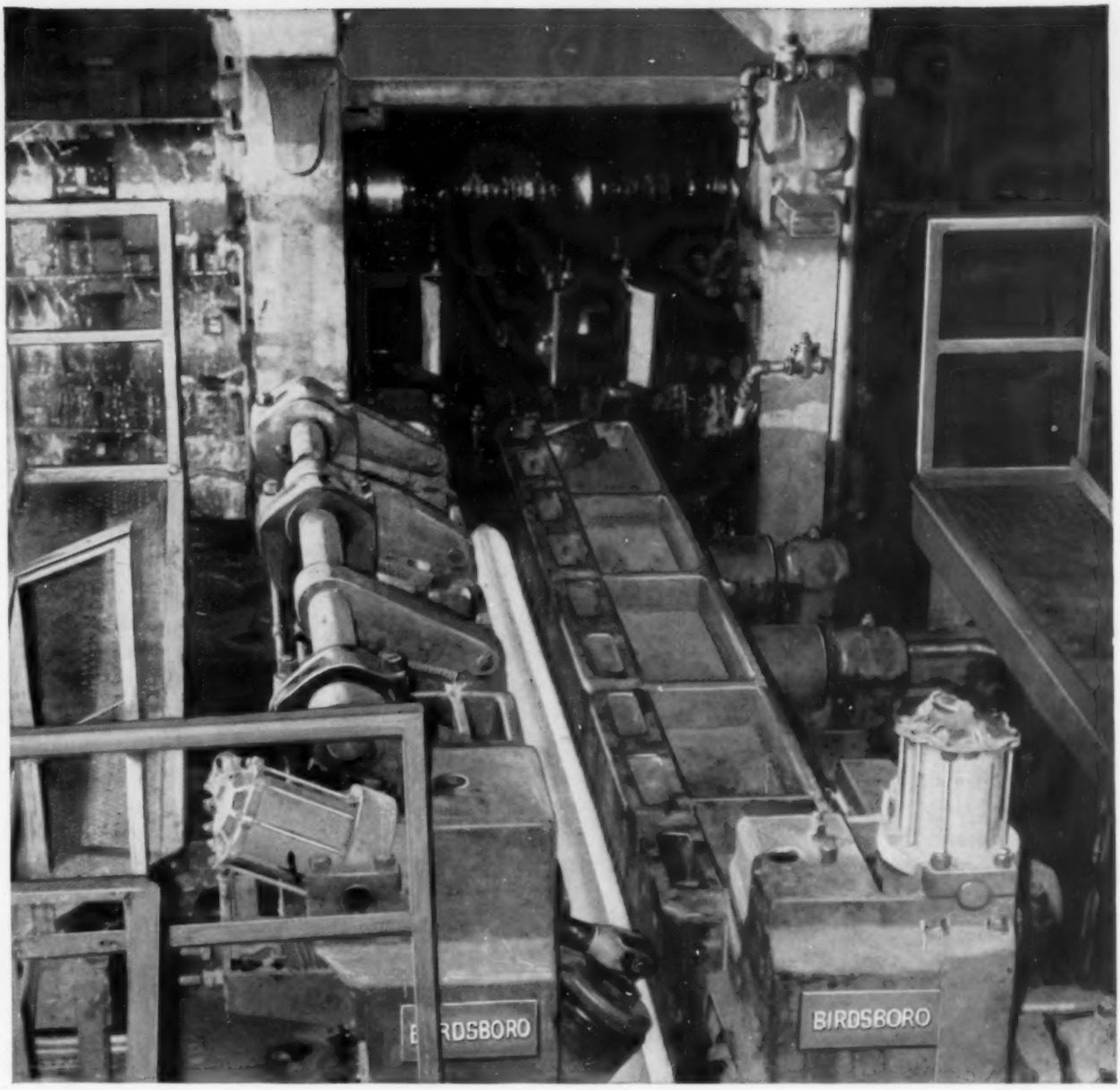
LUdlow 5-4400	EUclid 6-1700	ORchard 4-6600	Phone: 2-5561	WEstmore 1-3010	TUrner 5-7501



BIRDSBORO can help you cut costs with more *automatic* operation

Tonnage from this BIRDSBORO 3-high mill is raised substantially by semi-automatic features. These include tilting table, side guard manipulators, finger lift for turning square and rectangular shapes, and auxiliary manipulator for turning diamonds and squares.

Savings in labor costs, higher quality and dependable performance are other advantages you can count on when you call in BIRDSBORO engineers for anything from a single unit to a complete plant.

MM-42-55

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STEEL FOUNDRY AND MACHINE CO.

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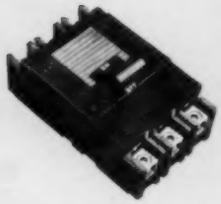
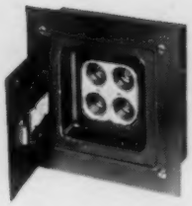
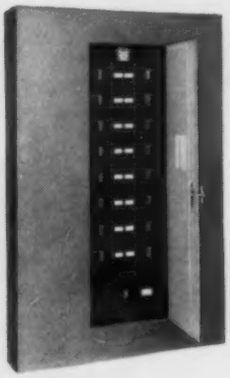


• Safety Switches and Industrial Circuit Breakers

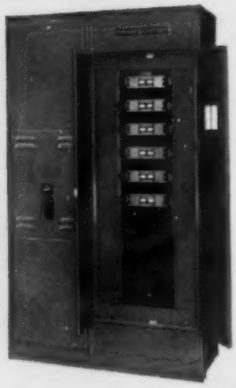


• Fusible and Circuit Breaker Load Centers

• Voltage Testers

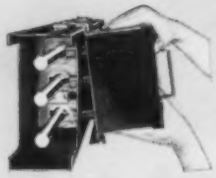


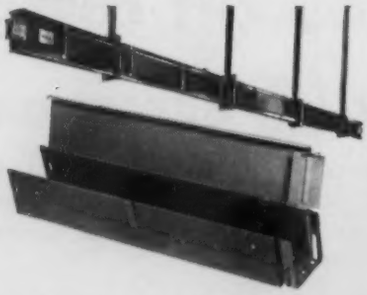
• Fusible and Circuit Breaker Lighting and Power Panelboards



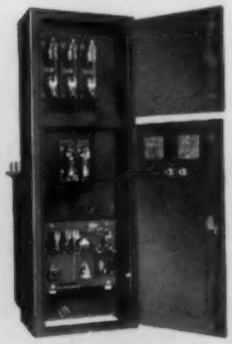
• Power Distribution Switchboards and Switchgear

Wherever Electricity

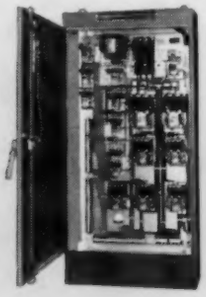




• Busways and Wireways



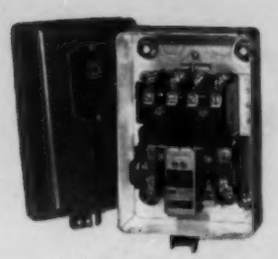
EC&M High Voltage and Synchronous Starters



• Special Purpose Control

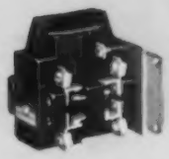
• Control Centers

SQUARE D COMPANY



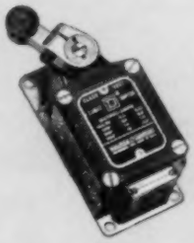
• A.C. Manual and Magnetic Starters

• Drum Switches



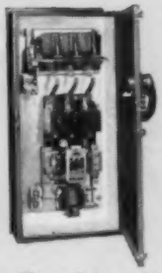
• Control Relays

• Timing Relays



• Limit Switches

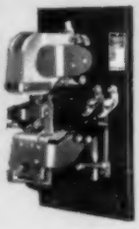
• Pushbuttons



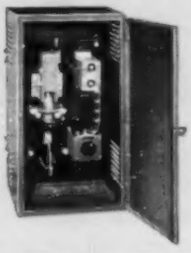
• Combination Starters

• Manual Compensators

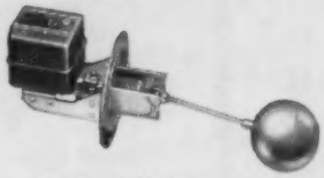
• All Types of Reduced Voltage Starters

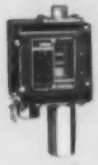


• D.C. Starters



• Electronic and Electro-Magnetic Welder Control





• Float & Pressure Controls for Pumps & Compressors

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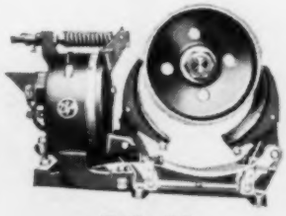

EC&M
Magnetic Brakes

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available through Square D branch offices
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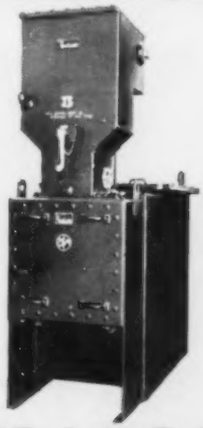
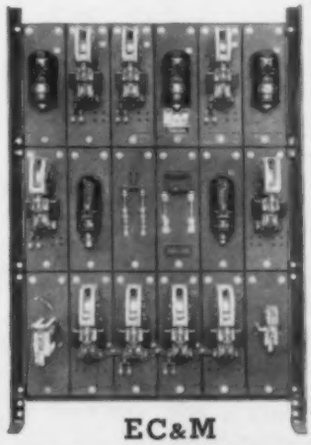
... and in Canada, Mexico and England



EC&M Explosion-Resisting
Control for
Petroleum Industry



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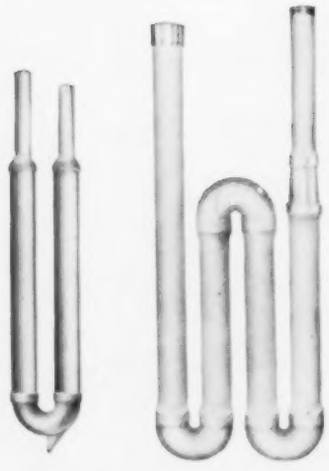
Perhaps you haven't. But the map shows how centrally located it is to major steel-producing centers . . . an advantage our steel mill customers seem to like.

If you *are* here sometime, we'd like to show you through our Electro-Alloys plant—one of the most modern alloy foundries in the country. You'll see a lot of steel mill parts being cast, too—because our steel-industry customers have found that *THERMALLOY** heat-resistant castings give long-life economy in many tough applications.

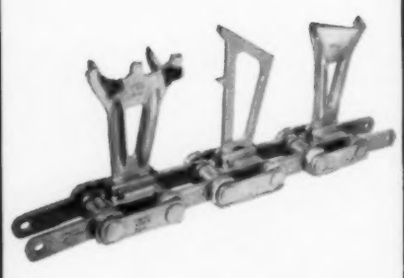
If you can't visit us, call our nearest sales representative. He'll put our expanded facilities to work for you on any high-heat-resistant casting requirement you may have, such as the parts shown below.

*Reg. U. S. Pat. Off.



Thermalloy Radiant Tubes Centrifugally cast, X-ray controlled, pressure-tested.

Thermalloy Furnace Rolls ...for roller-bottom furnaces.



Thermalloy Carrier Blades and Chain ...Three types of blades, mounted on *Thermalloy* conveyor chain.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION Elyria, Ohio

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period October 6, 1956 through October 30, 1956 . . . .

PRODUCTION OF LIGHT-GAGE SILICON IRON STRIP

▲U. S. 2,765,246, issued Oct. 2, 1956, to George R. Maxwell, Jr., and assigned to Allegheny Ludlum Steel Corp., describes a method of producing silicon iron strip having a thickness of 0.001 to 0.007 in.

The invention is based on the provision of a heat treatment to be applied to the fully annealed strip to increase its ductility without destroying its desirably large grain size.

The material is subjected to a temperature of 1400 to 1500 F for one to four minutes, and then cooled at a rate fast enough to prevent carbide precipitation at the grain boundary. Air-quenching is sufficient for this purpose, since the material being heat-treated will be about 0.018 in. thick.

The heat treatment effectively breaks up the continuity of the carbide envelope, thus imparting the desired ductility. Following the heat treatment, the steel is cold-rolled to the final thickness.

CLEAN GAS SEAL FOR BELL AND HOPPER

▲U. S. 2,765,935, issued Oct. 9, 1956, to Louis H. Schuman and assigned to Republic Steel Corp., describes a method for reducing erosive wear between the opposed surfaces of the hopper and large bell of a blast furnace.

The problem is solved by delivering clean washed furnace gas at about 100 F in a stream directed downwardly into the furnace and flowing in contact with the lower extremities of the bell and hopper adjacent to their engaging surfaces. Thus, the tendency for furnace gases to flow through any breach in the annular seal between these parts is minimized or eliminated due to the counterflow of the seal protecting gas.

Figure 1 shows one way of accomplishing the desired result. The large bell, furnace dome, and annular hopper-supporting girder are indicated by the letters B, D, and G, respectively. A hopper 10 extends down into the top of the furnace and is tapered toward its lower open end, engaging the lower outside surface of the bell B. Around the periphery of its lower end, the hopper is provided with a flange 11, having a number of apertures 14 opening adjacent to the bell-engaging surface of the hopper. A number of pipes 15 provide the supply of clean gas.

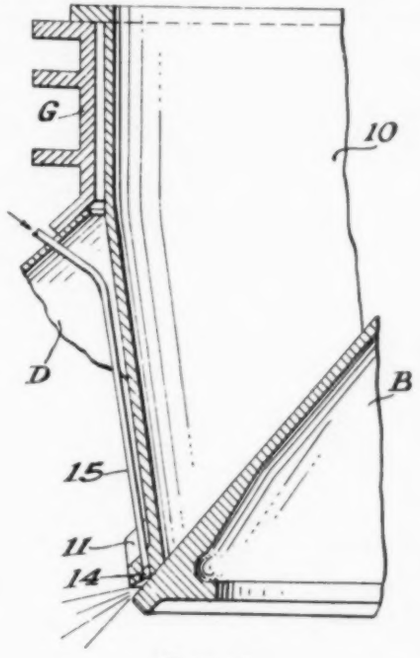


Figure 1

REDUCTION OF IRON ORES

▲U. S. 2,765,988, issued Oct. 9, 1956, to Olav Moklebust, assigned to National Lead Co., describes a process for the production from oxidic iron ores of a high-grade substantially pure iron concentrate suitable for conversion to steel in an open hearth, and a lower grade concentrate suitable for smelting in a blast furnace.

The ore is first mixed with coal, and is partially reduced at 600 to 1200 C. The product contains 60 to 90 per cent of its iron content in metallic form. After this partial reduction, the product is crushed in a ball or rod mill, converting the iron content to flake form. The crushed material is then classified in a wet classifier so that the flake metallic iron particles are separated as the heavy fraction, from the lighter fraction containing gangue and finer iron and iron oxide. After classification, the iron flake fraction is further treated by magnetic separation of low magnetic intensity to produce a product containing a total iron content of at least 90 per cent Fe and containing at least 80 per cent of metallic iron.

DEACTIVATION OF SPONGE IRON

▲U. S. 2,766,108, issued Oct. 9, 1956, to John E. Eberhardt, Hugh S. Graham, and Richard G. Gold, assigned to Bethlehem Steel Co., describes a process for the deactivation of compacted sponge iron.

When compacted sponge iron is stored, the underneath layers of chips begin to reoxidize, and this reoxidation continues until the material has reverted practically to the state of oxidation it was in prior to the reducing treatment.

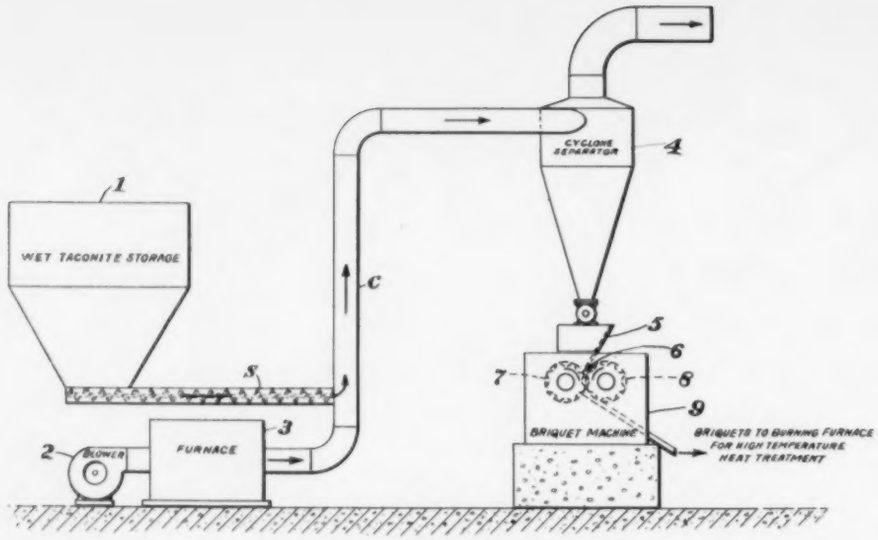


Figure 2

This can be prevented by allowing a slight initial oxidation of the chips to take place, and meanwhile subjecting them to a draft of cooling air. This cooling step arrests the oxidation before the chips have heated up more then 300 to 400 F, and further oxidation does not occur. The slight initial oxidation does not affect the utility of the material.

The initial oxidation may be performed by blowing air through a drum in which the chips are rotating at their discharge temperature (100 to 400 F). A clinker cooler may alternatively be used instead of the rotating drum, air being drawn down through the perforations.

BENEFICIATION OF TACONITE FINES

▲U. S. 2,766,109, issued Oct. 9, 1956, to Gustav Komarek and Karl R. Komarek, assigned to Komarek-Greaves and Co., describes a process for the beneficiation of taconite fines, in which briquettes of exceptionally high density and great strength are produced, and which are thus well suited for blast furnace operation.

As shown in Figure 2, the raw and wet taconite fines contained in a bin 1 are fed to a conduit C by means of a screw conveyor S into a turbulent stream of heated air or other gas (such as products of combustion) supplied to conduit C by blower 2 and furnace 3. This gas stream conveys the fines to a cyclone separator 4. Contact between the turbulent stream of heated gas and the fine particles of taconite in the conduit C will almost instantly dry the taconite fines and heat them to the desired temperature (200 to 600 F). The turbulent stream of heated gas, resultant water vapor and dried and heated taconite fines are delivered tangentially into the cyclone separator 4, where the taconite fines are separated from the gaseous mixture which accompanies them. The discharge end 5 of the cyclone separator is positioned directly above the nip 6 of two briquetting rolls 7 and 8 of a conventional briquetting machine 9.

The total elapsed time between the time the cold and wet taconite fines are fed to the stream of heated gas in the conduit C and the time the briquettes are discharged is only about ten seconds.

The briquettes are subjected to a final heat treatment at about 1900 F, converting the magnetite in the taconite to hematite.

It was found that, while it was not possible to produce satisfactory briquettes from raw taconite fines, the same fines, after the above treatment, produced briquettes of high density and satisfactory mechanical strength.

OPERATION OF ELECTRIC ARC FURNACES

▲U. S. 2,766,313, issued Oct. 9, 1956, to Carl Reschke and assigned to Demag-Elektrometallurgie G.m. b.H., describes a method and apparatus for automatically regulating the depth of an electrode in the charge of an electric arc furnace or a reduction furnace.

In electric arc furnaces and reduction furnaces, the depth of immersion of the electode in the charge is constantly regulated. This depth in turn regulates the current consumption of the furnace.

This regulation cannot always be properly maintained since the electrode may assume an unfavorable position within the charge due to an improper makeup of the charge or for other reasons.

In open furnaces, the defective composition of the charge and the resultant change of the electrode position can be quickly rectified. However, in covered furnaces, this defect is very difficult to ascertain and it cannot be easily corrected.

This difficulty is overcome in the present invention by transmitting an electrical or ultrasonic impulse from the upper end of the electrode to the bottom end within the charge, receiving the reflected impulse, establishing the elapsed time, and varying the depth of the electrode within the charge until the elapsed time reaches a predetermined value.

DRUM-TYPE PICKLING MACHINE

▲U. S. 2,766,562, issued Oct. 16, 1956, to Othmar Ruthner, describes a drum-type pickling machine for removing rust and scale from coiled iron strip, when the coils are of

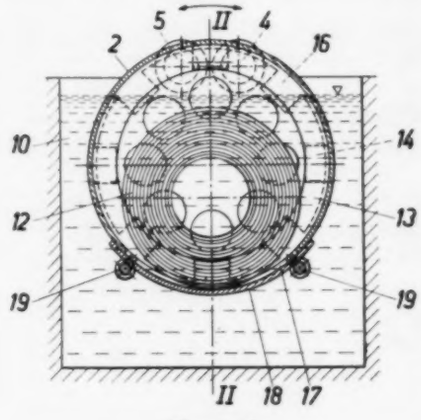
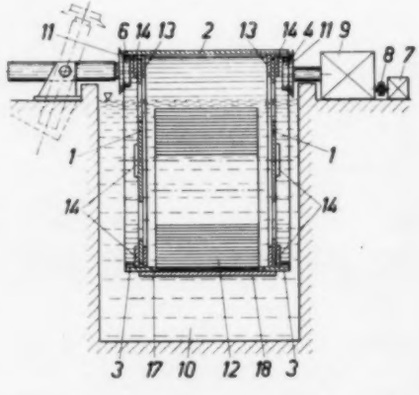


Figure 3

Figure 4



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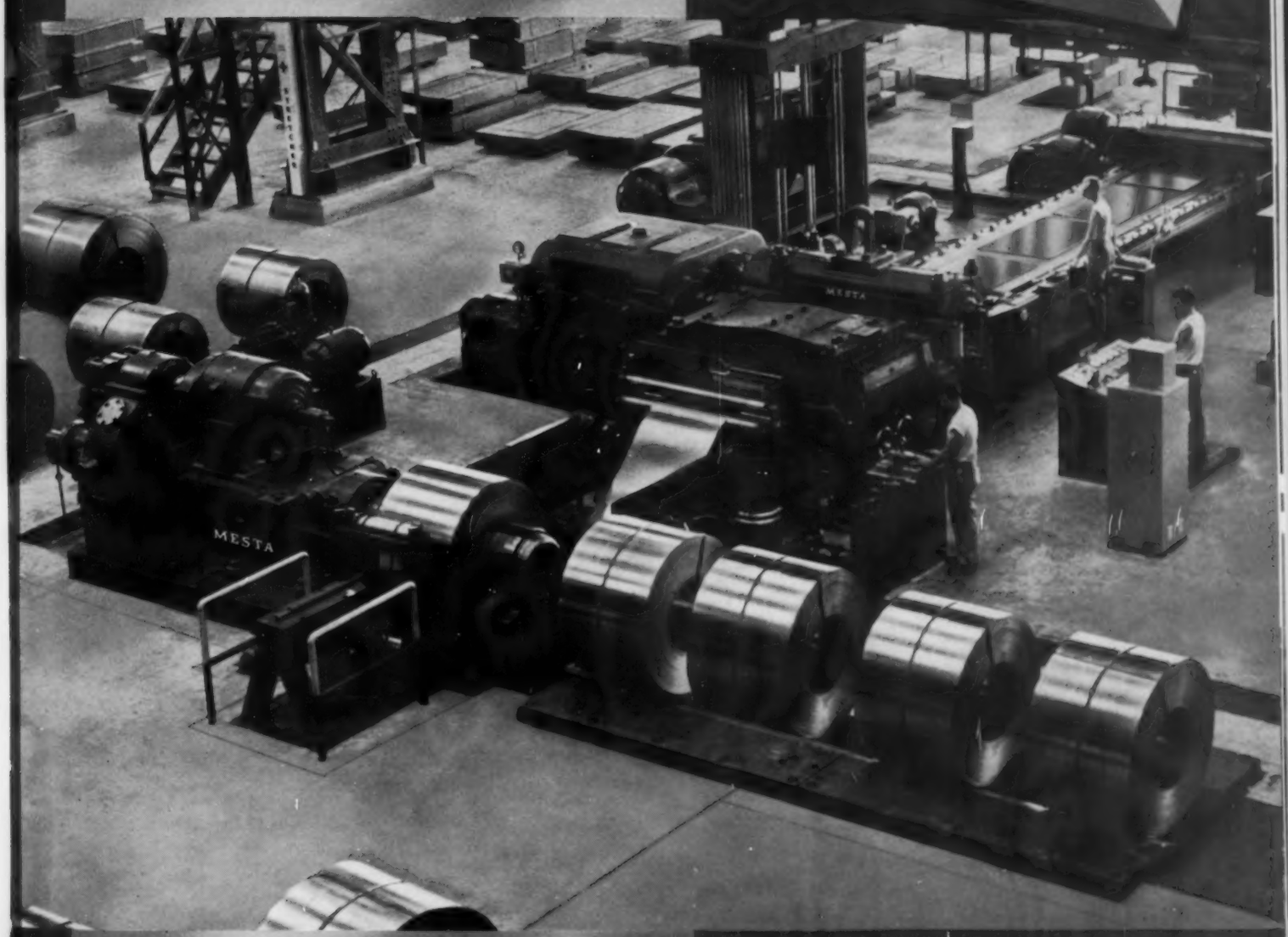

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high weight and large width.

As shown in Figures 3 and 4, the pickling drum consists of the drum end walls 1 and the drum shell 2, which extends beyond the drum end walls, its projecting parts forming the rims 3, with which the drum rests on rollers 4, 5 and 6. Roller 4 is driven by motor 7 through the coupling 8 and gear unit 9. The roller 6 is pivoted to enable the drum to be lifted out of the pickling tank 10. The rollers carry lateral drip disks 11, which prevent the acid, which flows from rims 3 onto the rollers, from attacking the shafts of the rollers and entering the bearings of the rollers. The drum contains the coil 12 to be pickled, which is completely immersed in the acid. Fumes formed in the tank are sucked off by a suction unit.

METHOD OF INCREASING SINTER RATE

▲U. S. 2,767,074, issued Oct. 16, 1956, to Cyril Bradwell and assigned to Bethlehem Steel Co., describes a method of increasing the speed of a sintering operation by means of preheating the mix.

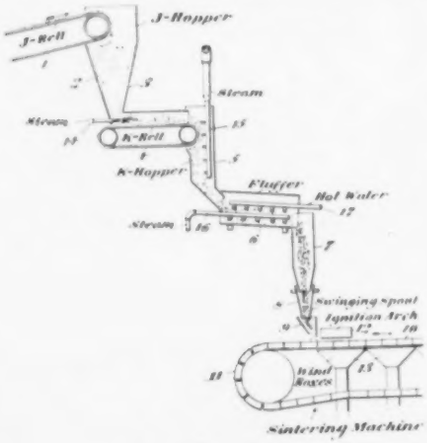
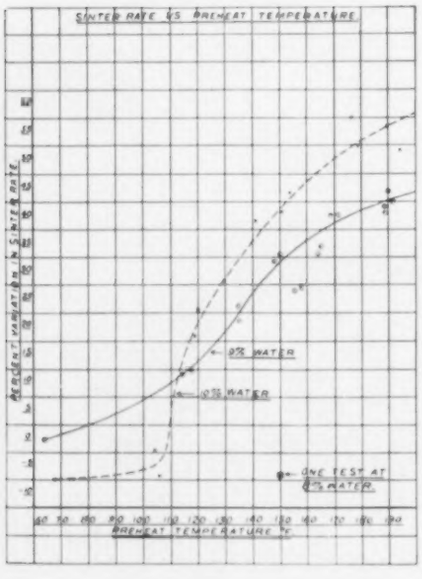


Figure 5

Figure 6



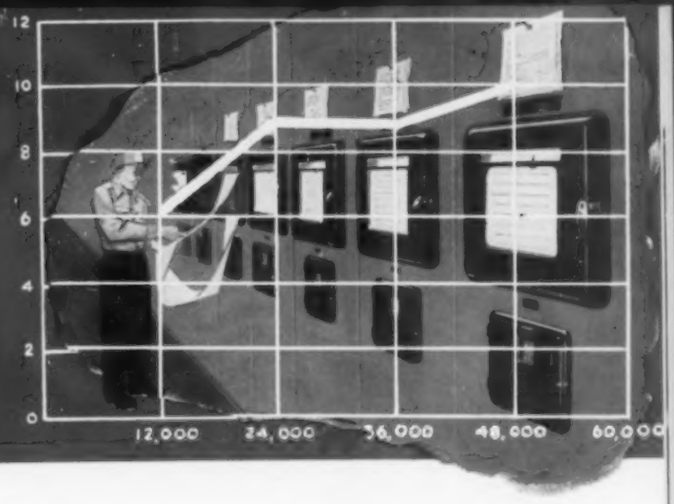
In Figure 5, the numeral 1 designates a conveyor belt or so-called J-belt, from which the mix 2 falls through J-hoppers 3 onto covered K-belt 4, upon which the mix is advanced and drops through K-hopper 5 into a rotating drum type fluffer mixer 6. From the fluffer mixer 6, the mix drops through hopper 7, swinging spout 8 and hopper 9 onto the moving grate 10 of a sintering machine, on which the mix travels under ignition arch 12 and over wind boxes 13 and is ignited and sintered. By means of multi-jet perforated pipes 14, 15 and 16, steam is injected into the mix on the K-belt 4, in the K-hopper 5 and fluffer mixer 6, respectively. Similarly, hot water for

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,765,266	10/2/56	Bulk density control of coking coal	Koppers Co.
2,765,360	10/2/56	Electrically heated shaft furnace for dry reduction of iron ore with hydrogen	Norsk Hydro-Electrisk Kvaelstofaktieselskab
2,765,934	10/9/56	Charging car for open hearth	National Steel Corp.
2,766,041	10/9/56	Apparatus for automatically centering and alining moving strip	United States Steel Corp.
2,766,043	10/9/56	Magnetic sheet handling apparatus for inspection of tin plate	Dario Buccione
2,766,115	10/9/56	Recovery of metal values from complex ores containing iron and nickel	Republic Steel Corp.
2,766,117	10/9/56	Heat treating powdered metal parts	Republic Steel Corp.
2,766,211	10/9/56	Production of magnetic iron oxide powder from mill scale	The National Cash Register Co.
2,766,736	10/16/56	Water-cooled roof door for an electric arc furnace	Celso Ciamberlini
2,766,824	10/16/56	Ingot shearing machine	Schloemann Aktiengesellschaft
2,766,888	10/16/56	Magnetic separation of ores	Augustin L. J. Queneau
2,766,895	10/16/56	Work removing conveyor mechanism for heat treating furnaces	Alfred Ruckstahl
2,766,896	10/16/56	Charging of cupolas	Stuart J. Smith
2,766,980	10/16/56	Regenerative furnaces	Rudolph L. Hasche
2,767,075	10/16/56	Direct reduction of iron ore containing nickel	Albert E. Greene
2,767,077–9	10/16/56	Desiliconizing and desulphurizing pig iron	Societe d'Electro-Chimie d'Electro-Metallurgie et des Acieries Electriques d'Ugine
2,767,080	10/16/56	Process for reducing oxidic ores	Frans M. Wiberg
2,767,084	10/16/56	Alloy for deoxidizing steel	Vanadium Corp. of America
2,767,236	10/16/56	Magnetic stirrer for molten metal furnaces	James W. Williamson
2,767,456	10/23/56	Method for making tie plates	United States Steel Corp.
2,767,467	10/23/56	Solid phase bonding of metal strips	Metals & Controls Corp.
2,767,601	10/23/56	Counterbalance cylinder for forging presses	Erie Foundry Co.
2,767,602	10/23/56	Cluster type edge rolling mill	United States Steel Corp.
2,767,603	10/23/56	Semi-automatic screw-down control for rolling mills	United States Steel Corp.
2,767,604	10/23/56	Apparatus for monitoring the operation of rolling mills	Mark E. Whalen, Jr.
2,767,738	10/23/56	Valve assembly for open-hearth furnaces	Blaw-Knox Co.
2,767,835–8	10/23/56	Process of extruding steel	La Salle Steel Co.
2,767,843	10/23/56	Magnetic induced roll ore separator	James H. Carpenter
2,767,844	10/23/56	Comminuted ore feed control	James H. Carpenter
2,767,971	10/23/56	Rotary tilting furnace	Demag Aktiengesellschaft
2,768,413	10/30/56	System for controlling the flow of molten metal	Allegheny Ludlum Steel Corp.
2,768,542	10/30/56	Bridle roll assemblage for a rolling mill	Kaiser Aluminum & Chemical Corp.
2,768,635	10/30/56	Heat treatment apparatus	Westinghouse Electric Corp.
2,768,890	10/30/56	Method of sintering	Martin L. Cover
2,768,892	10/30/56	Non-aging steel	Jones & Laughlin Steel Corp.
2,768,915	10/30/56	High temperature aluminum-iron base alloys	Joseph F. Nachmann, et al.
2,768,916	10/30/56	Continuous bluing system for ferrous strip	Wheeling Steel Corp., et al.
2,768,977	10/30/56	Elimination of phenol from coke plant effluents	Allied Chemical & Dye Corp.

SEVENTH OF A SERIES

Customer's Report



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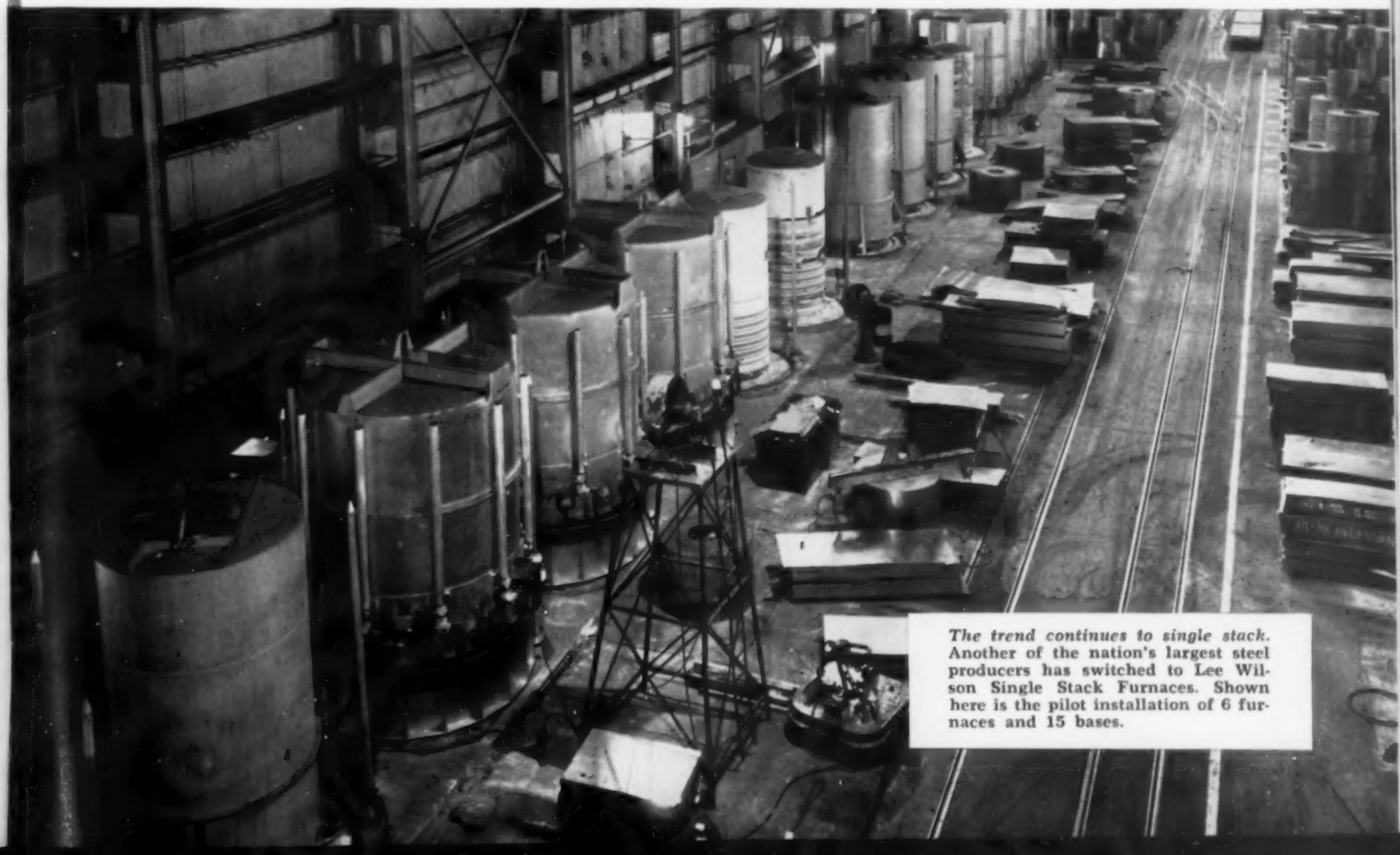
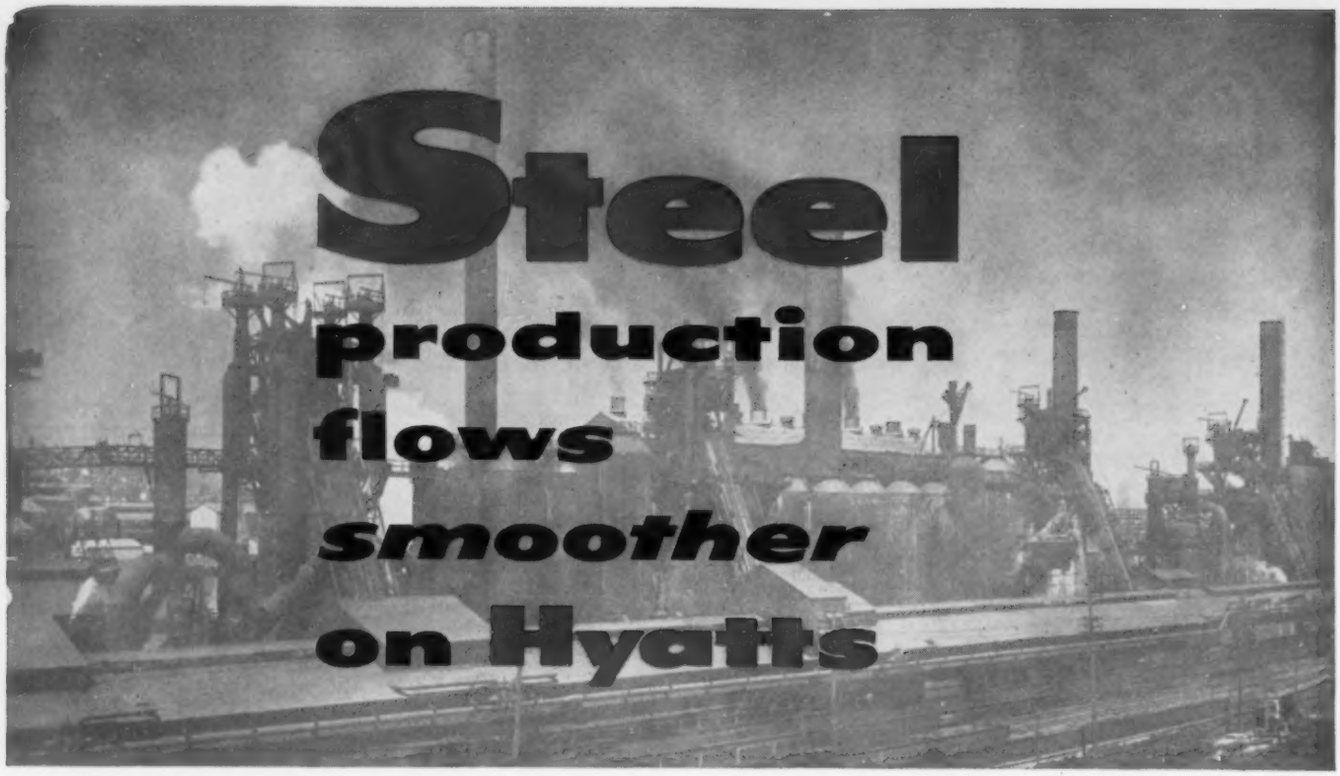
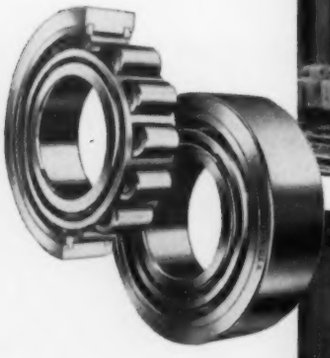


The trend continues to single stack. Another of the nation's largest steel producers has switched to Lee Wilson Single Stack Furnaces. Shown here is the pilot installation of 6 furnaces and 15 bases.



-from ingot cars to runout tables!



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tempering is added by means of perforated pipe 17 in fluffer mixer 6.

The curves in Figure 6 illustrate the effect of preheating a typical mix whose optimum moisture content is 9 or 10 per cent when it is prepared and sintered in the normal manner. The solid line shows how the weight of sinter produced in a given time increases with increase in preheat temperature of the mix.

MECHANICAL REMOVAL OF SCALE FROM STEEL STRIP

▲U. S. 2,767,413, issued Oct. 23, 1956, to Warren G. Herrington and assigned to The Fuller Brush Co., describes a method of mechanical removal of scale from steel scrap, by the use of brushes.

As shown in Figure 7, the strip is moved longitudinally, while a number of transverse brushes do the cleaning action. As shown in Figure 8, the brushes 18 are transversely offset from each other, so that adjacent brushing actions are in overlapping zones. In Figure 8, the letter S indicates the uncleaned portions of the surface, and C the cleaned portions.

LOW TEMPERATURE REDUCTION OF IRON ORES

▲U. S. 2,767,076, issued Oct. 16, 1956, to Charlton A. Taylor, describes a continuous process for the low temperature reduction of iron ore to metal below its fusion temperature, using gaseous hydrogen as the reducing agent.

Crushed dry ore of 100 to 500 mesh particle size is fed at the top of a vertical shaft furnace (Figure 9). Preheated hydrogen is supplied to the reaction zone at intervals along its length, as is also oxygen or combustion air to provide the necessary temperature. Nitrogen may also be added at various points in order to control the temperature. The gas flows up through the furnace, countercurrent to the ore, and leaves at the top.

The furnace is divided into an upper, intermediate, and lower zones by means of slight restrictions. Beneath the reaction zone is a zone through which the metallized solid particles of the ore pass and are enveloped by a cooling gas before being withdrawn.

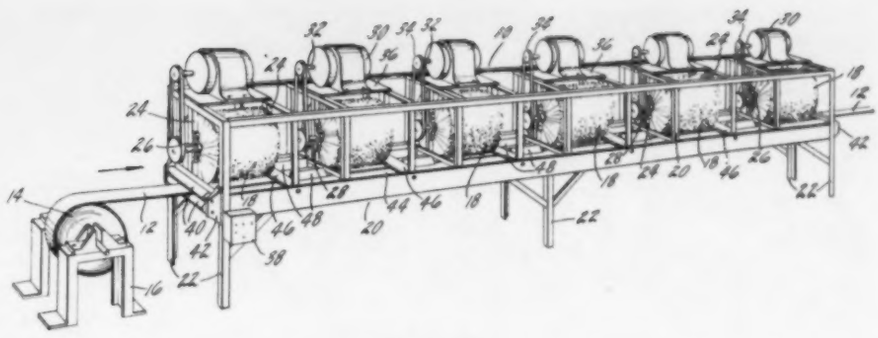


Figure 7

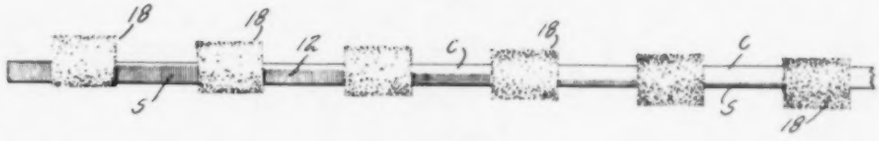


Figure 8

Figure 9

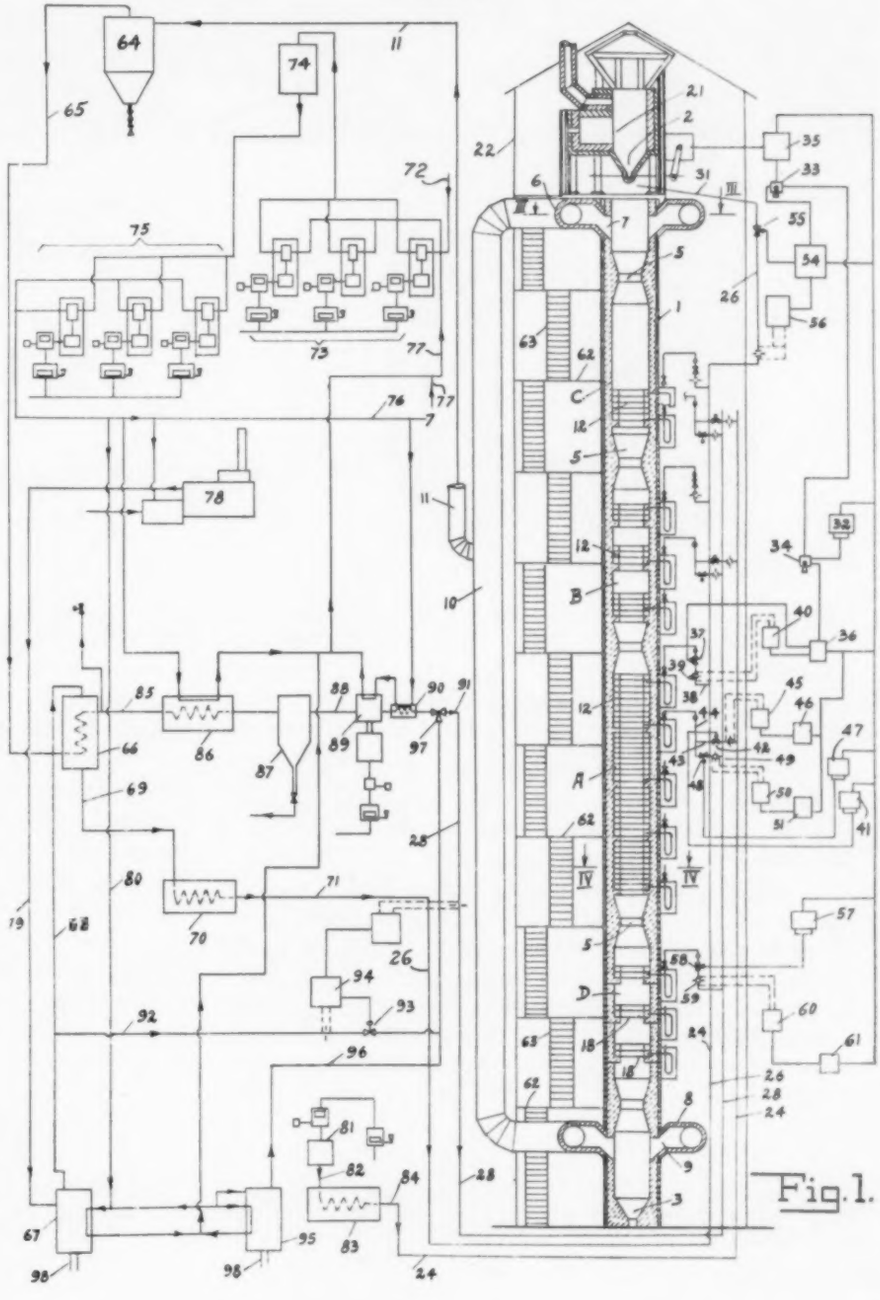
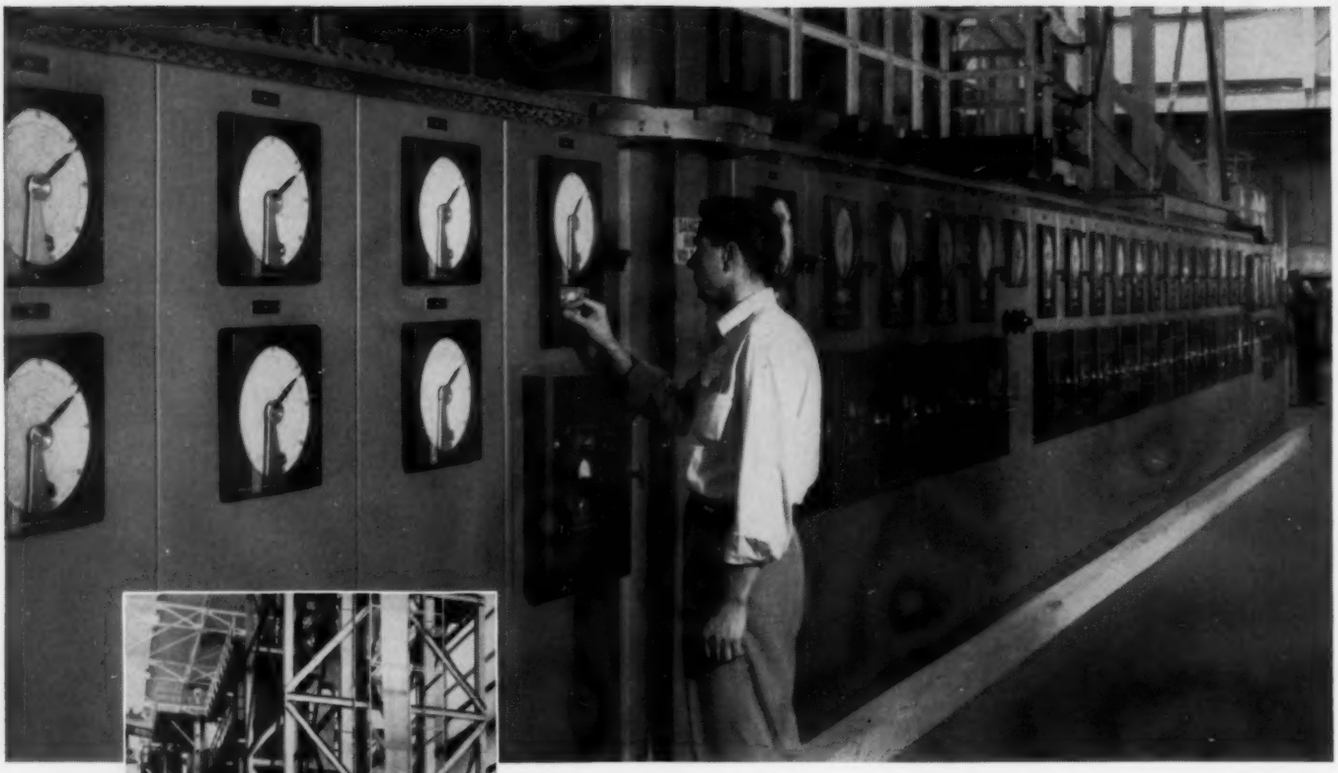
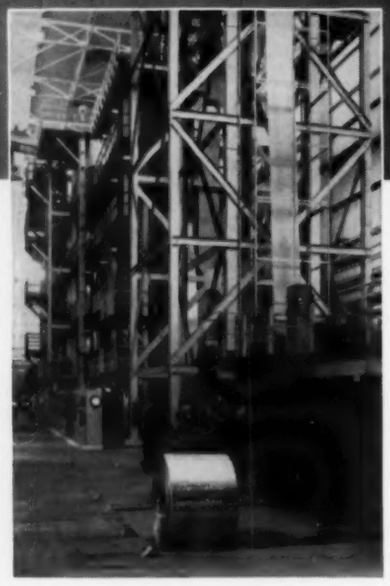


Fig. 1.





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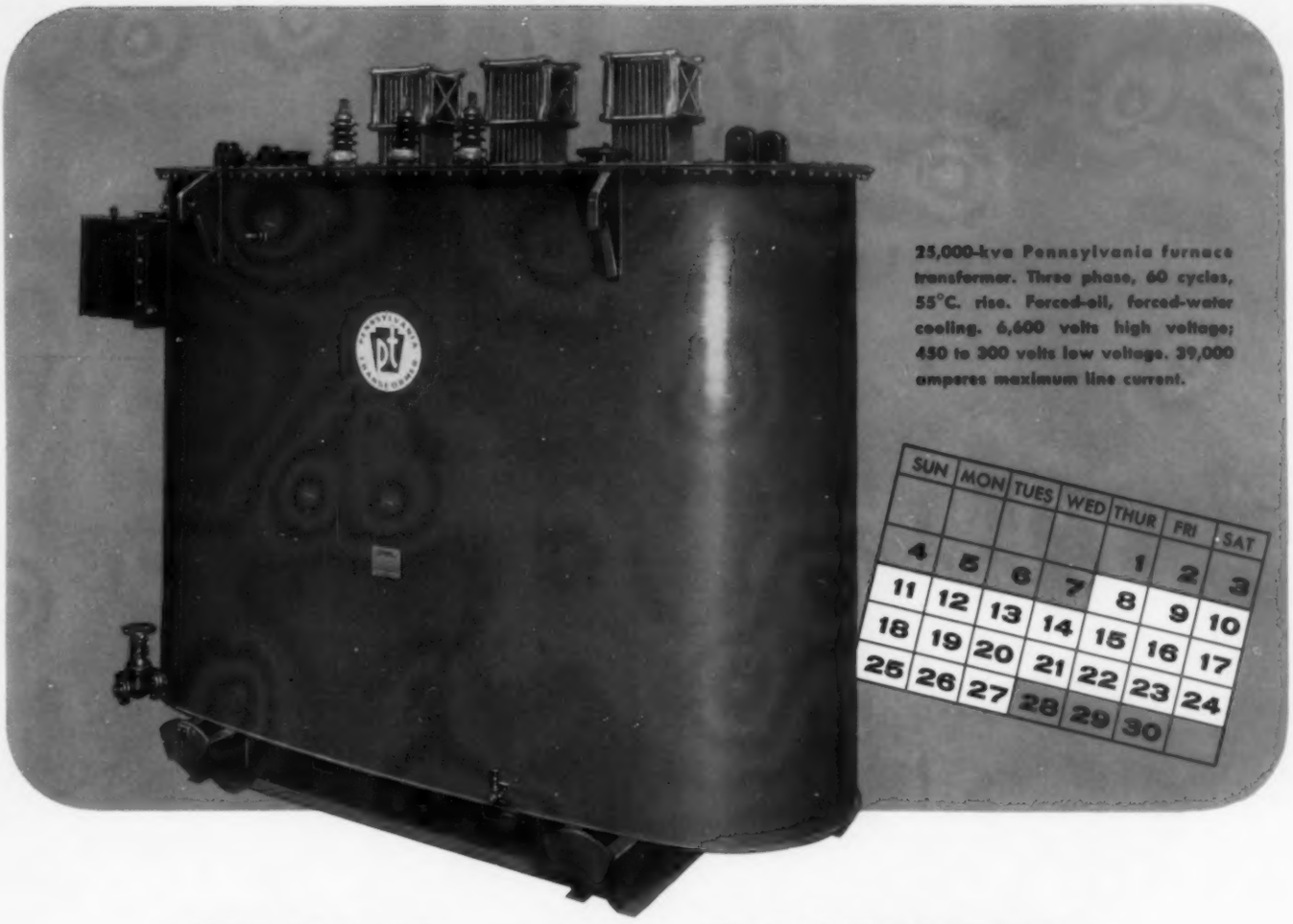

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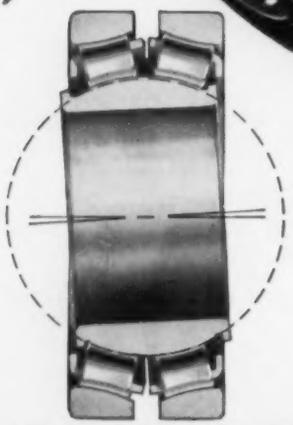

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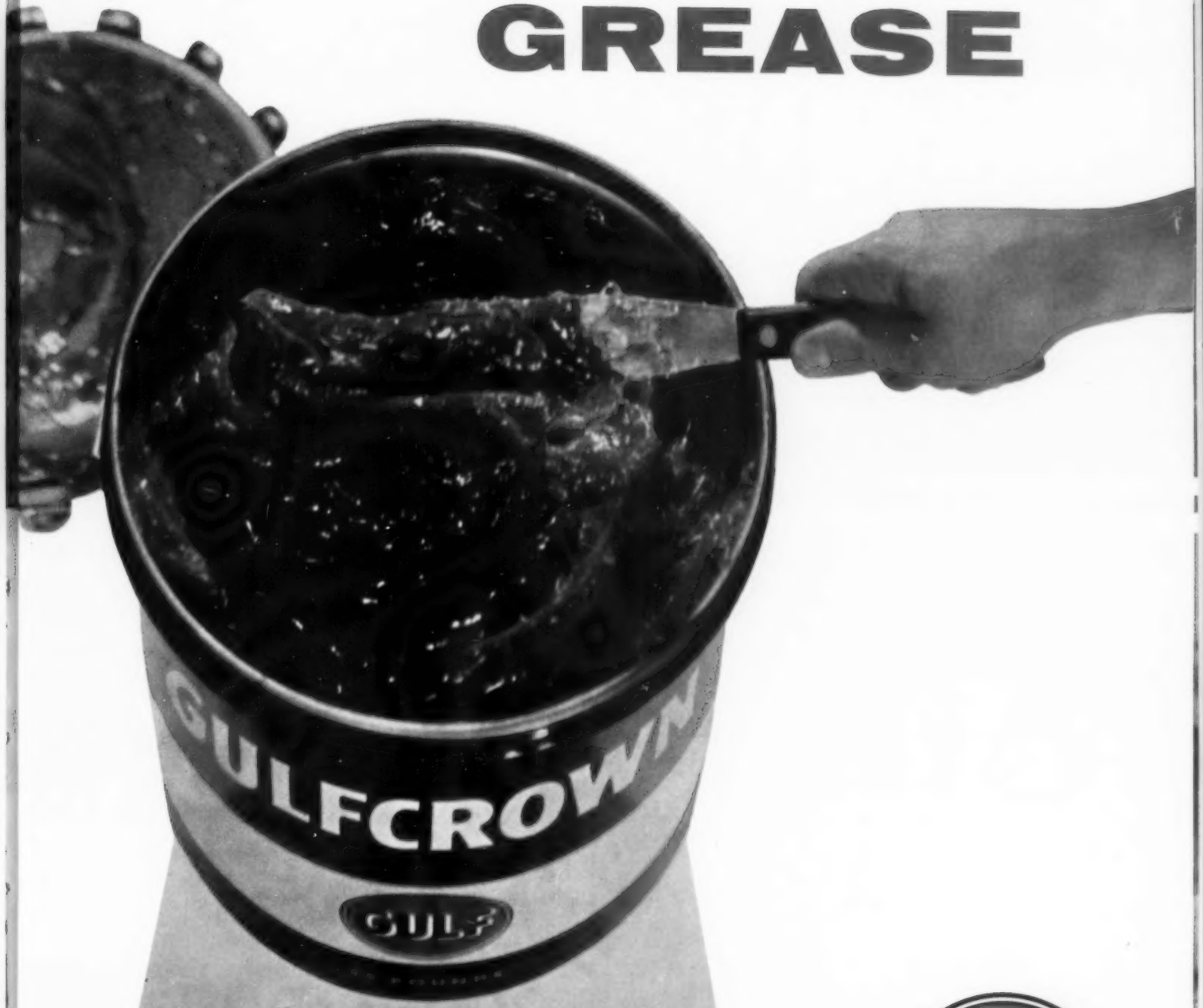

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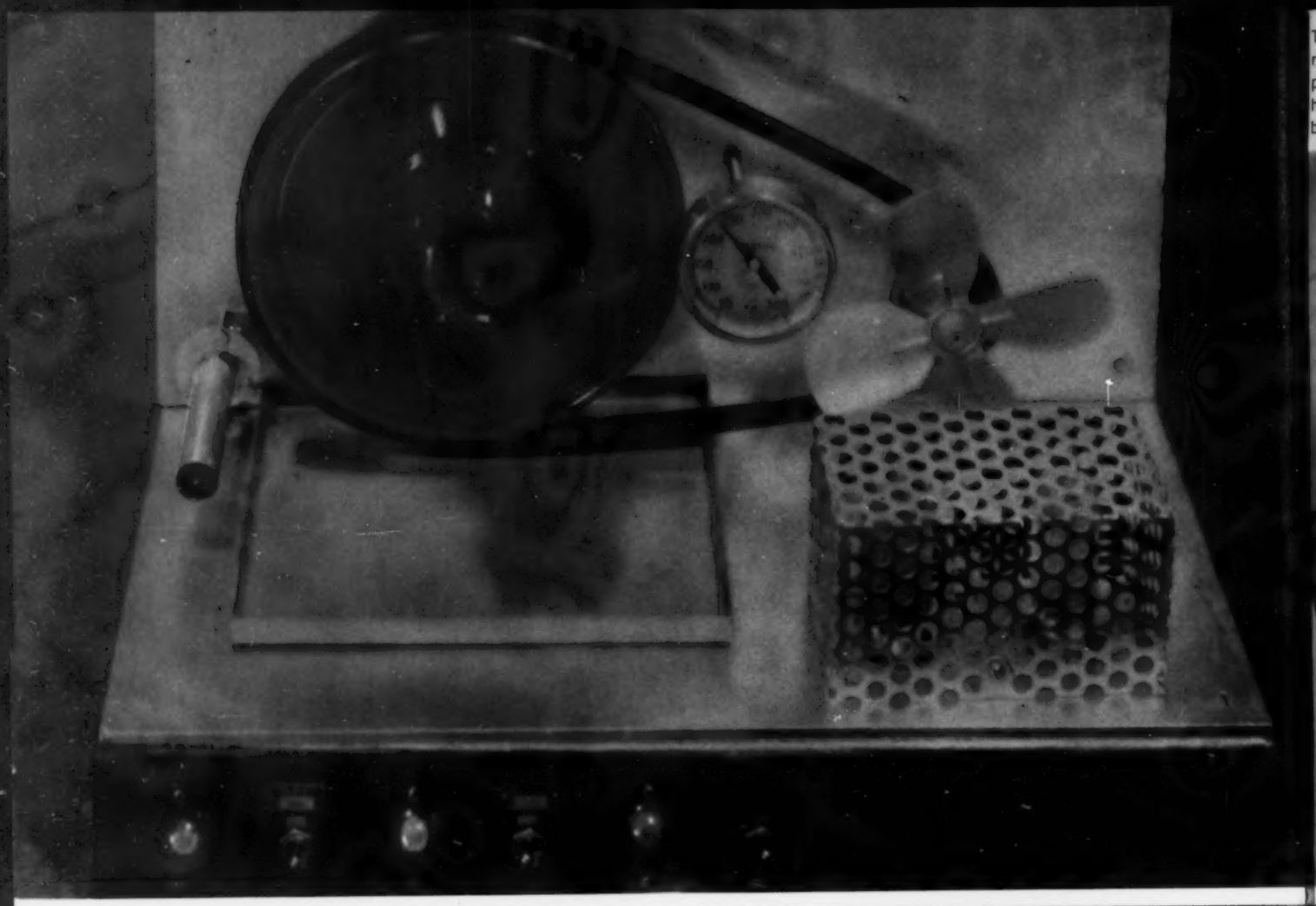

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- Reduces inventory
- Cuts lubrication costs

This bearing packed with Gulfcrown Grease was run at 750 rpm in a special oven heated to 250°F. Gulfcrown "stays put" . . . doesn't run out even after thousands of hours at high operating temperatures. And the bearing remains in brand-new condition.

Samples of Gulfcrown (shown on 4 steel plates) are sprayed with water heated to 130°F. Note how Gulfcrown adheres, doesn't wash away.

Excellent oxidation stability

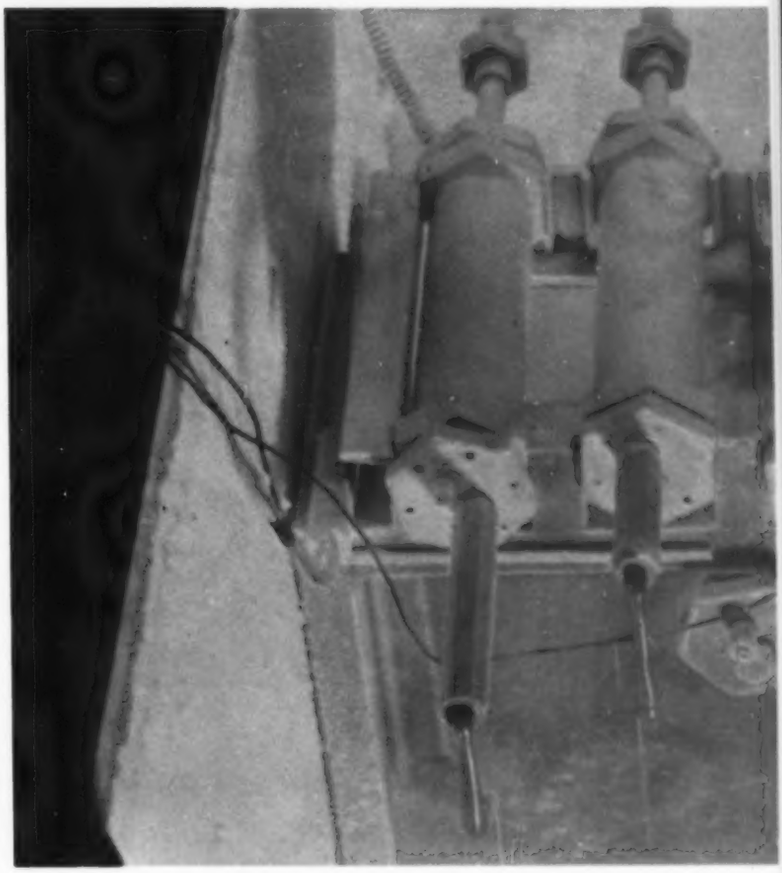
Gulfcrown is effectively inhibited against oxidation to insure long life, both in storage and in use.

Unsurpassed working stability

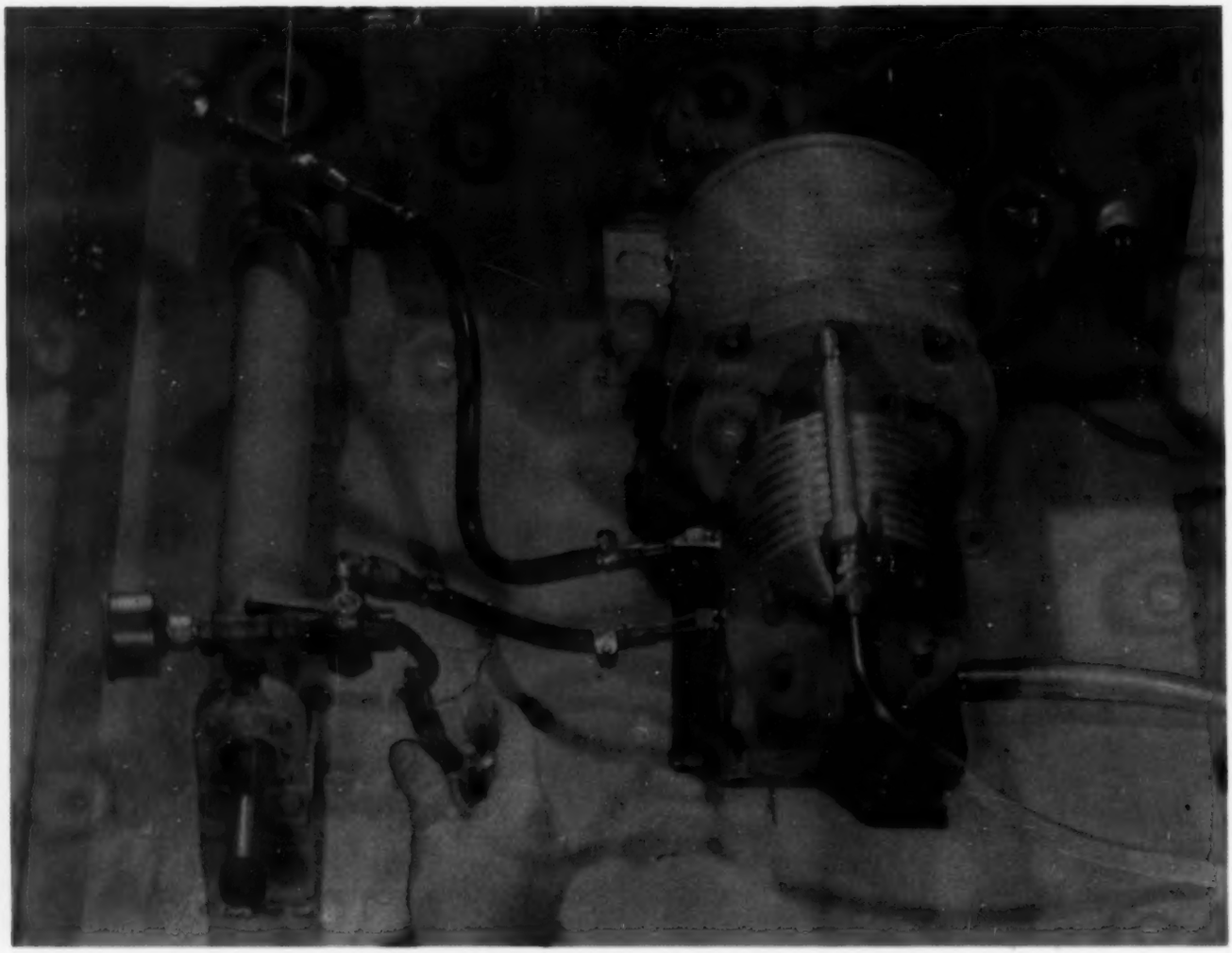
Gulfcrown Grease stands up under the churning action of high-speed bearings even at high temperatures. This means less grease consumption, less frequent applications. It is ideal for centralized grease systems—it pumps easily and will not separate.

Resists water

Gulfcrown Grease is highly resistant to the washing action of water. It provides excellent lubrication and protects against rusting even under the dampest conditions.



Gulfcrown Grease pumps easily even in coldest weather. Temperature in this freezer chest is 0°F.



This grease stability testing machine, developed at the Gulf Research Laboratory, provides additional evidence of the mechanical stability of Gulfcrown Grease. Gulfcrown does not break down in consistency even after being pumped through a bearing operating at 1725 rpm.

Gulfcrown is available in 4 consistencies. Your Gulf Sales Engineer will gladly help you make proper selection. Call him at your nearest Gulf office . . . or use the coupon below.

GULF OIL CORPORATION
1822 Gulf Building, Pittsburgh 30, Pa.

Gentlemen:

☐ Please send me free literature on new Gulfcrown.
☐ Please have a Gulf Sales Engineer call on me.

Name_____

Company_____

Title_____

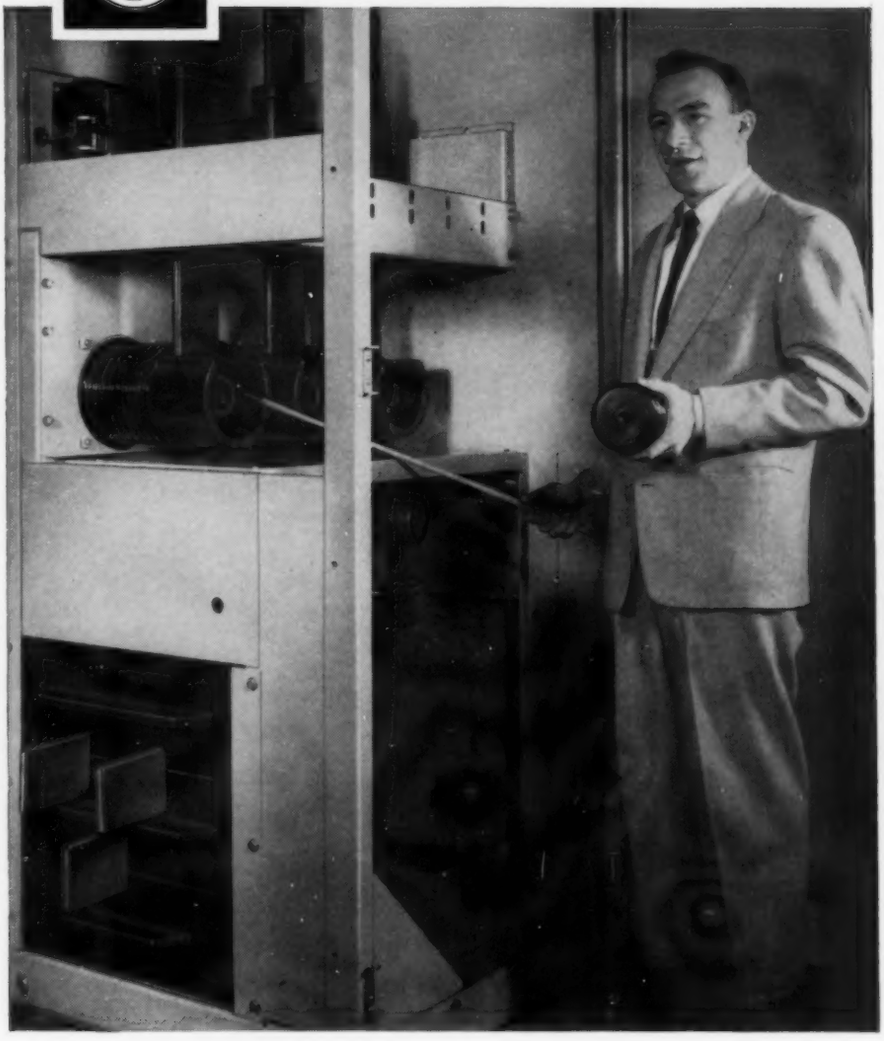
Street_____

City_____ Zone_____ State_____

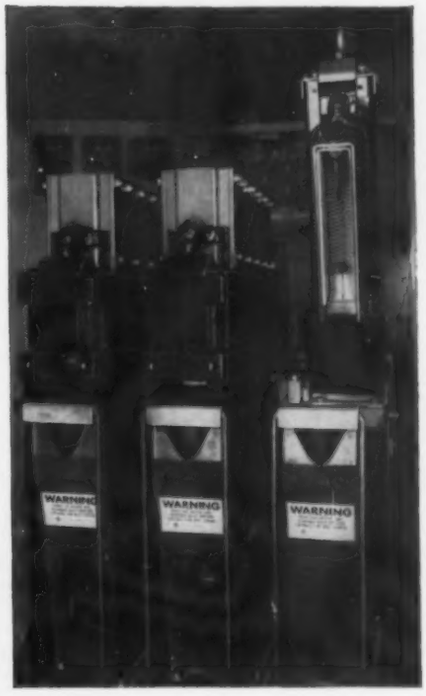
GULF

SP-89

METAL-CLAD SWITCHGEAR



PURIFIED PORCELAIN in horizontal and vertical bus supports, primary disconnect bushings and caps and epoxy in bus joint covers provide excellent insulation, prevent fires in 15 kv I-T-E metal-clad switchgear.



EPOXY AND SPECIAL CERAMICS protect personnel and equipment by preventing fires in the circuit breaker section. Arc chute rear supports and blowout coils are epoxy. Jump gap cooling plates, arc chute liner plates, arc plates and spacers are special ceramics.

Only the finest fire-protective insulating materials

Nonflammable porcelain and ceramics, flame-resistant epoxy, and other flame-retardant insulating materials throughout, are among the extra values you find in I-T-E Metal-Clad Switchgear. Purified porcelain, of which the primary disconnect bushings and caps are made, also supports both vertical and horizontal bus. It is nonflammable, has high dielectric strength, won't track or deteriorate, is inherently contamination free.

Epoxy, which can be molded into complicated shapes, forms arc chute rear supports, blowout coils, bus joint covers, potential and current transformers. It has high mechanical and dielectric strength, is nontracking and extremely flame resistant.

Special ceramics, highly resistant to direct arc exposure, are used in jump gap cooling plates, arc chute liner plates, arc plates and spacers. These have high dielectric strength, low moisture absorption, won't track, are excellent interrupting materials. They do not deteriorate when subjected to direct arc exposure. They absorb thermal shock and deionize gases without excessive heating.

Phenolic and polyester insulating sheets and moldings, specially treated to provide the highest possible degree of flame-retardant characteristics, are also used.

If you are planning new construction or modernization requiring electric power, consider the advantages of I-T-E equipment. Consult your local I-T-E sales office or write I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY • Switchgear Division

IN CANADA: EASTERN POWER DEVICES, LTD.

Always, at SKF, you will receive unbiased advice

because

– All four basic types of anti-friction bearings are available from **SKF.**

because

– They offer an extraordinarily wide range of sizes and combinations to meet virtually any requirement.

because

– Their long experience in the widest variety of bearing applications is your assurance of receiving sound recommendations.

because

– Thousands of manufacturers have been using the **SKF** Bearing Advisory Service for many years – always with good results. This dependable service is available to you, too. 7784

SKF

EVERY TYPE—EVERY USE

- *Ball Bearings*
- *Cylindrical Roller Bearings*
- *Spherical Roller Bearings*
- *Tapered Roller Bearings (Tyson®)*

® Reg. U.S. Pat. Off. Tyson Bearing Corporation

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

Three Rust-Oleum DIFFERENCES that save you time, money and metal!

GOES ON FASTER

No tedious surface preparations usually required — just scrape and wirebrush to remove rust scale and loose rust — then brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining rust.

STOPS RUST

Rust-Oleum's *specially-processed* fish oil vehicle works down through the rust into the tiny, microscopic pits in the bare metal where it drives out air and moisture to *stop rust.*

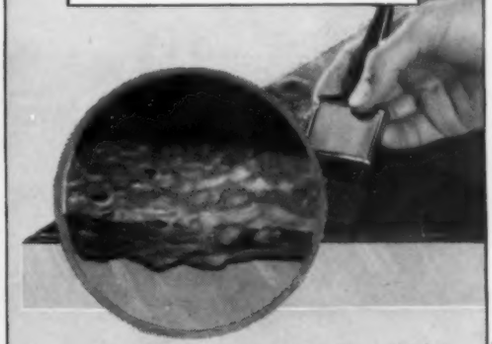
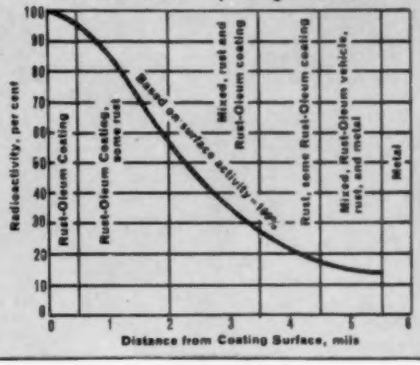
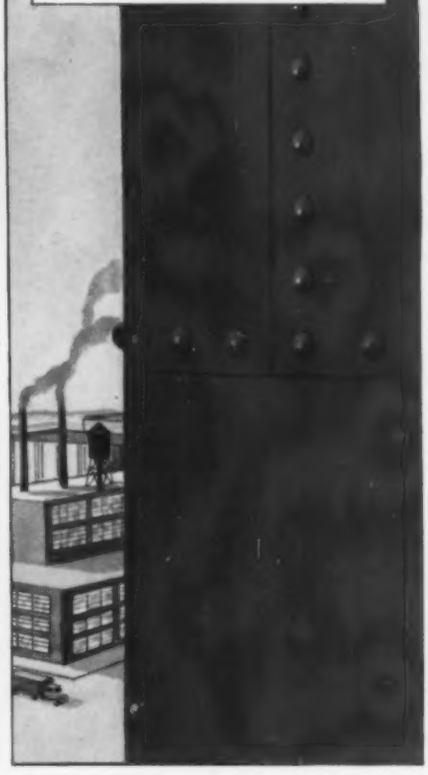


Chart shows results of tracing radio-activated Rust-Oleum through rust to bare metal by Geiger Counter.



LASTS LONGER

Applied over rust, Rust-Oleum lasts longer for the *over-the-years protection* you need. It resists sun, salt water, salt air, fumes, heat, humidity, moisture, weathering.



These are just a few of many important *differences* that separate Rust-Oleum from ordinary coatings. When you consider that Rust-Oleum covers approximately *30% more area,* depending upon surface condition and porosity . . . and the fact that Rust-Oleum finish coatings, with the same fish oil vehicle, are available in nearly every color for *double protection* . . . it's just good, common sense to use Rust-Oleum. Prompt delivery from Industrial Distributor stocks. Write for illustrated literature with color charts.

RUST-OLEUM®

STOPS RUST!®

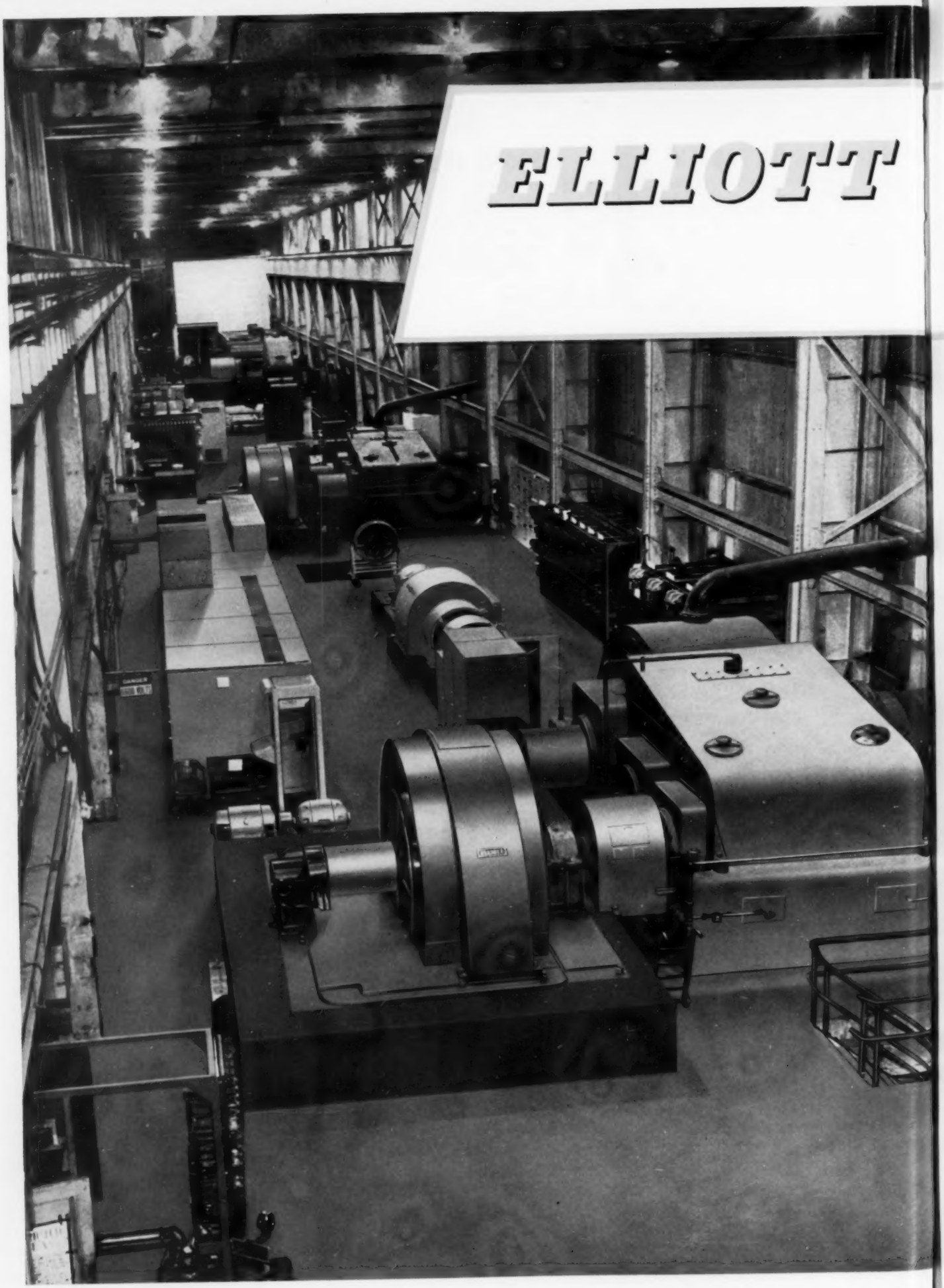
Rust-Oleum is distinctive as your own fingerprint. Accept no substitute.

ATTACH TO YOUR LETTERHEAD — MAIL TODAY

Rust-Oleum Corporation
2444 Oakton Street • Evanston, Illinois

- ☐ Complete literature with color charts.
- ☐ 30-page report on Rust-Oleum penetration.
- ☐ Nearest source of supply.

Rust-Oleum and Stops Rust are brand names and registered trademarks of the Rust-Oleum Corporation.


ELLIOTT

6000-Horsepower SYNCHRONOUS MOTORS

drive new roughing stands in Weirton's 54-inch hot strip mill

FOR DRIVING three roughing stands in the new 54-inch hot strip mill at Weirton Steel Company, a division of National Steel Corporation, Elliott 6000-horsepower synchronous motors were chosen. These motors, which are the largest in the mill, provide exceptionally high pull-out torque. An ingenious feature of the application is the Elliott mechanical "inching drives," which, by applying new principles to an old problem, facilitate fast and economical roll removal and replacement.

The steel industry uses many Elliott steam and electrical products, and they are all represented at Weirton. Large and small motors, strainers of various capacities, blast furnace compressors, steam turbines and condensers, deaerating heaters are among the items supplied to Weirton during the past 40 years.

For complete information on Elliott steel mill equipment, get in touch with the nearest Elliott District Office, or write Elliott Company, Ridgway, Pennsylvania.

FASTEST OF ITS SIZE

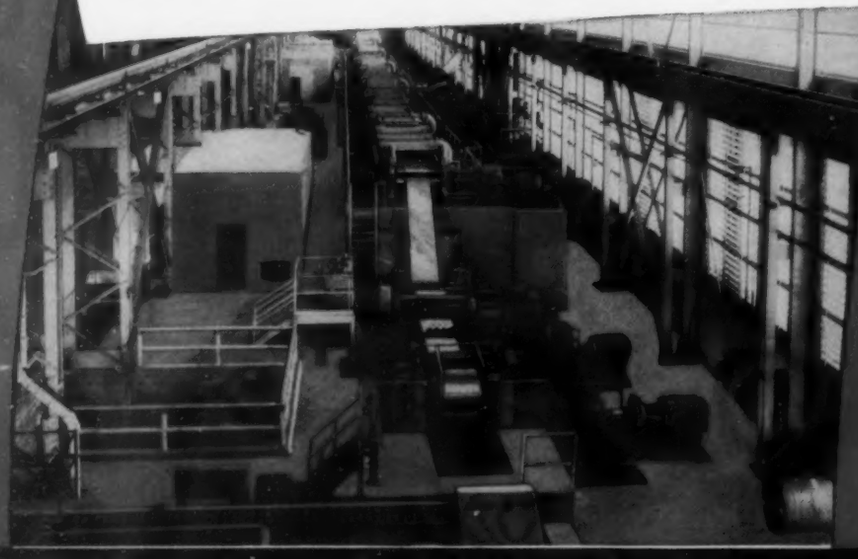
Shown above is one of the three 6000-hp, 450-rpm, 6900-volt Elliott motors which drive the new roughing stands of the modernized Weirton 54-inch hot strip mill—the fastest of its size in the industry.

ELLIOTT Company

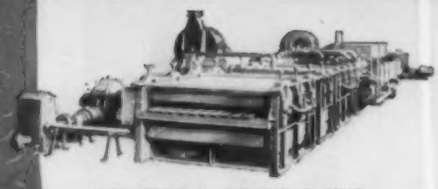
STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS
EJECTORS • CONDENSERS • CENTRFIGUAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

R6-25

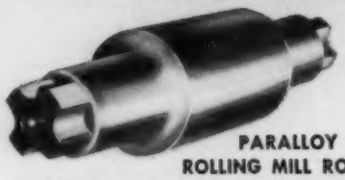
"YOUNGSTOWN" EXPERIENCE PAYS OFF IN BETTER RESULTS FOR YOU



Steel Mill Equipment - Heavy Machines - Complete Lines

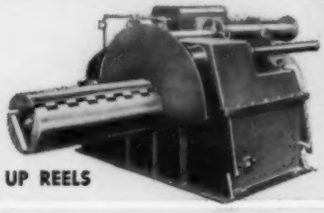


SCRUBBER & CLEANING LINE

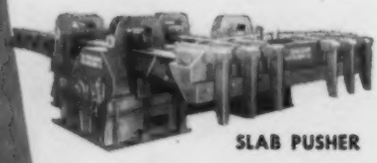


PARALLOY ROLLING MILL ROLLS
MERCHANT—ROD—BAR—SKELP

36" CONTOUR ROLL LATHE

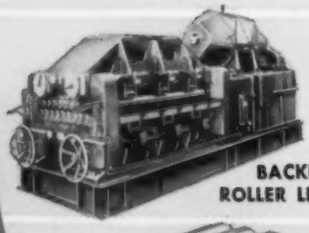


TAKE UP REELS

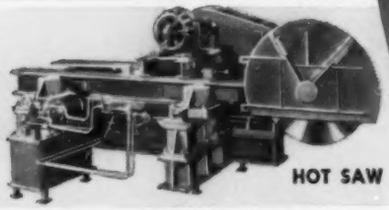


SLAB PUSHER

90" x 240" x ¼" STRETCHER LEVELER



BACKED UP ROLLER LEVELER



HOT SAW

DUCTILE RUN-OUT TABLE ROLLS

"Youngstown" Machinery serves major steel mills from coast to coast

"Youngstown" is well-known for its 70 years of experience in the designing, engineering and building of heavy, steel mill machinery. Pictures at left show a few examples . . . Complete lines—major units and auxiliaries. Additional "YF&M" products include ductile iron gears, rolls and castings up to 100,000 pounds.

"Youngstown" also builds extrusion presses and equipment for the "light metals" industry.

Modern Pickling Line cuts costs for western mill

Better pickling with less acid consumption . . . "Youngstown's" latest high speed continuous strip pickling line utilizes a new pull-thru type TRIPLE SCALE BREAKER that eliminates the need for a pinch roll stand.

Complete Scrubber Line built for midwest plant

This typical sheet scrubber line provides the ideal solution to the cleaning problem involving enamel sheet stock, dry or oiled stock, sheets for tin plating and special service sheets.

36" Contour Roll Lathe wins laurels for new improvements

Completely hydraulic tracer control insures smoother, more accurate finish. Featured improvements provide better turning, either on necks or centers. Built to suit specific needs.

Slitting Line speeds production for brass manufacturer

This complete 25" slitting line for brass and copper is giving "right-for-the-job" service. "Youngstown" has the correct answer for any slitting problem, whether it is .002" brass, copper, aluminum, or ⅜" steel plate.

Ductile Run-out Table Rolls excel in hot strip mill

Ductile cast iron rolls are reducing maintenance in leading mills. Especially good under the sprays. Resist heat check and breakage. Ductile iron is the ideal maintenance material for aprons, roller boxes, looper tables and looper rolls.

Consult us about your problems.
Let us quote on your requirements.

The Youngstown Foundry & Machine Co.

SERVING INDUSTRY SINCE 1885

Y&M

Youngstown, Ohio

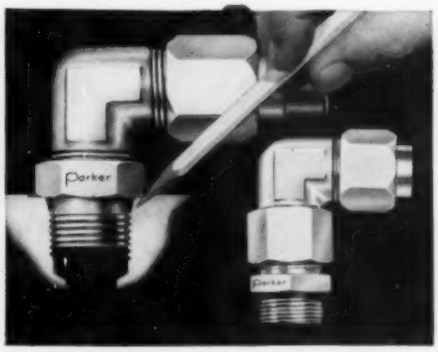
Be sure to see Parker for both tube and hose fittings!

Here, from one convenient source, you can get the most advanced hydraulic fittings available . . . both tube *and* hose. For example, new Parker *no-skive* Hoze-lok fittings require no stripping of rubber-covered hydraulic hose. They're faster, easier to use and *re-usable.*

Also, new Parker *straight-thread* tube fittings solve high-pressure hydraulic leakage problems resulting from tapered pipe threads. *Straight* threads are available on Triple-lok (the industrial standard flare tube fitting) and on Ferulok (flareless fitting for heavy steel tubing).

Parker
Hydraulic and fluid system components

No-skive Hoze-lok fittings need no stripping of hose covers. Only two simple steps complete the make-up. Re-usable.



Straight-thread tube fittings provide leakproof, trouble-free connections. No overtightening. O-ring makes the seal.

TUBE & HOSE FITTINGS DIVISION
Section 422-L
The Parker Appliance Co.
17325 Euclid Ave., Cleveland 12, Ohio

- ☐ Please send *no-skive Hoze-lok* Catalog No. 4433
- ☐ *Triple-lok* Catalog No. 4310
- ☐ *Ferulok* Catalog No. 4320

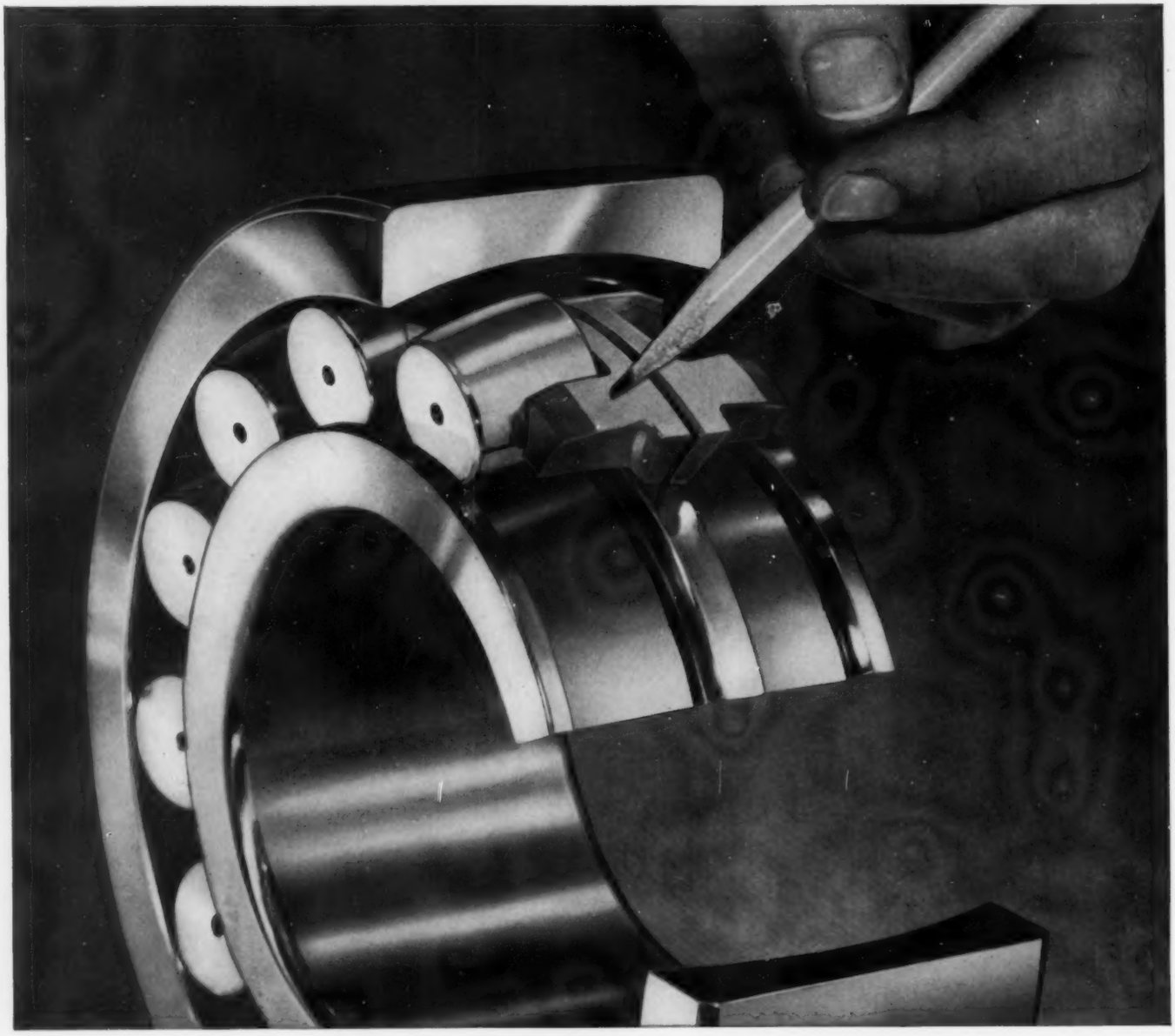
NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

TORRINGTON *SPHERICAL ROLLER* BEARINGS



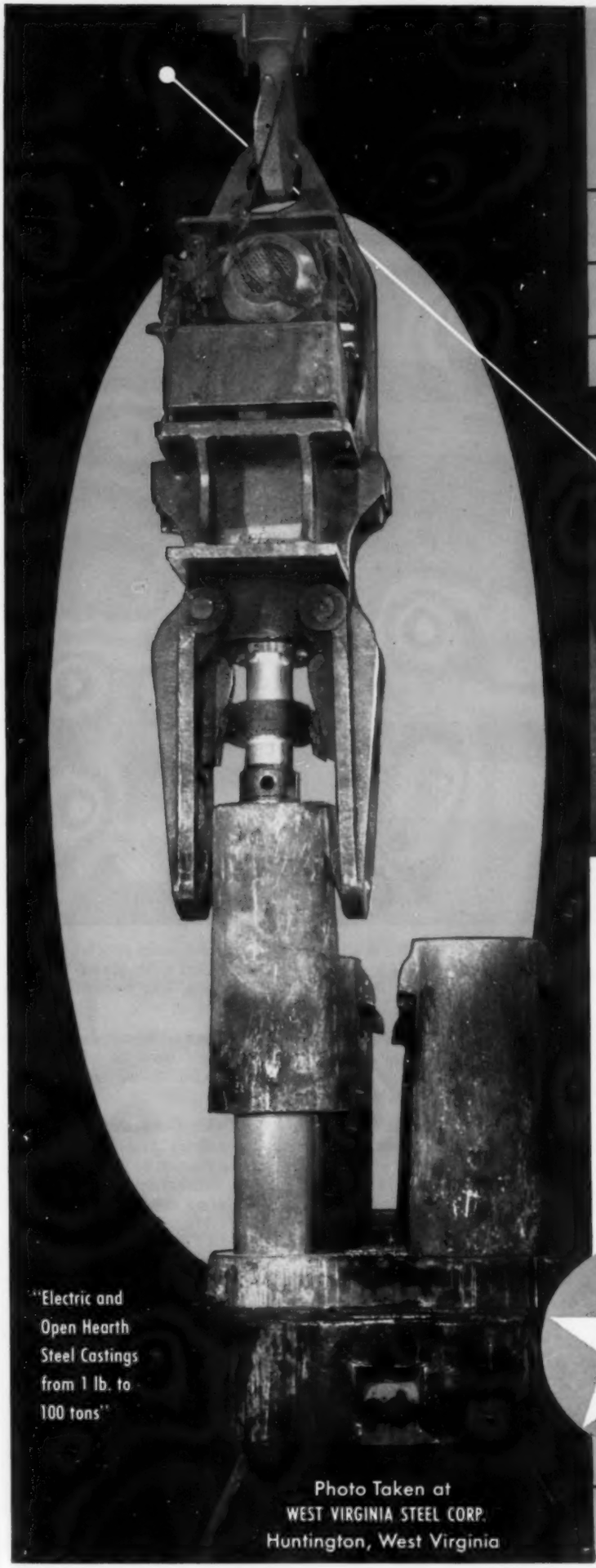
Land-riding cages for longer life!

These fully machined cast-bronze, land-riding cages—one for each path of rollers—are important performance builders in TORRINGTON'S Spherical Roller Bearings. The one-piece retainers keep the rollers perfectly aligned at all times, even under conditions of shock load and sustained speeds. Lubrication is more effective, too, as the lubricant has easy access to vital points of contact between rollers and races.

This feature is typical of TORRINGTON'S design, made possible through long experience in serving industry with the finest in precision bearings. That's why it pays to look to TORRINGTON first when your application calls for Spherical Roller Bearings. They're available from stock with either straight or tapered bore, for shaft or adapter mounting.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District offices and distributors in principal cities of United States and Canada

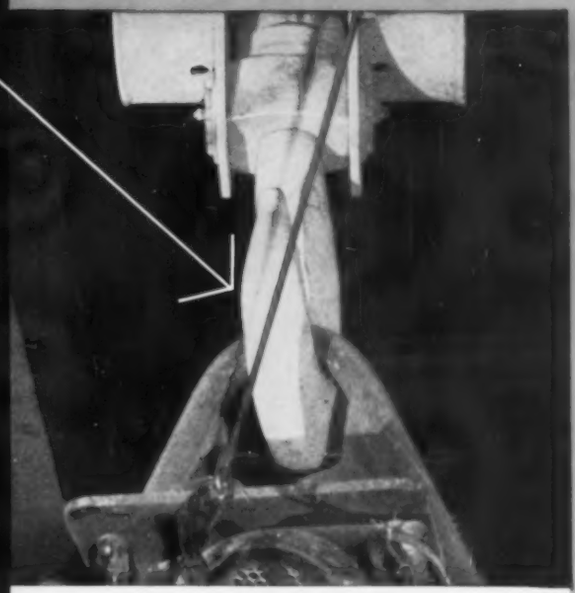
TORRINGTON BEARINGS
Spherical Roller • Tapered Roller • Cylindrical Roller
Needle • Ball • Needle Rollers



"Electric and Open Hearth Steel Castings from 1 lb. to 100 tons"

Photo Taken at
WEST VIRGINIA STEEL CORP.
Huntington, West Virginia

portable ingot stripper



lower cost... greater efficiency

Present users of our Portable Ingot Stripper report savings in mold cost and reduced overhead expense as the crane can be used for other jobs when the stripper is not in use. Two sizes available—250 and 450 tons—easily modified to handle hot tops.

Write for New Portable Ingot Stripper Folder

Pittsburgh
ENGINEERING & MACHINE CO.

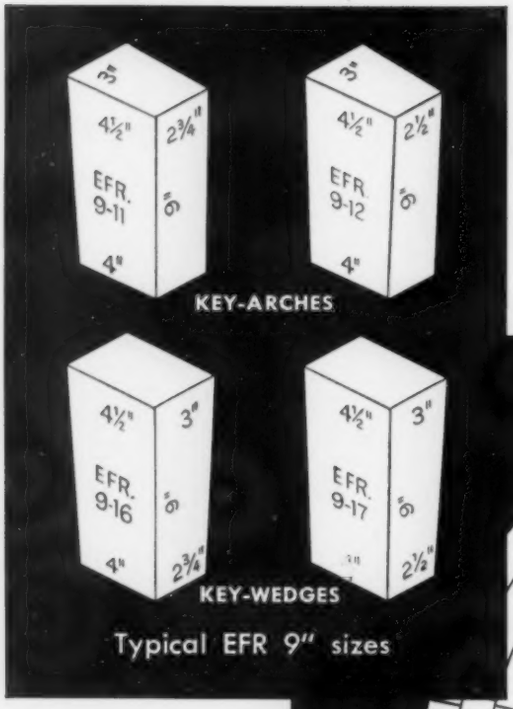
Division of Pittsburgh Steel Foundry Corporation

P. O. BOX 986, PITTSBURGH 30, PENNSYLVANIA
PLANT AT GLASSPORT, PENNSYLVANIA

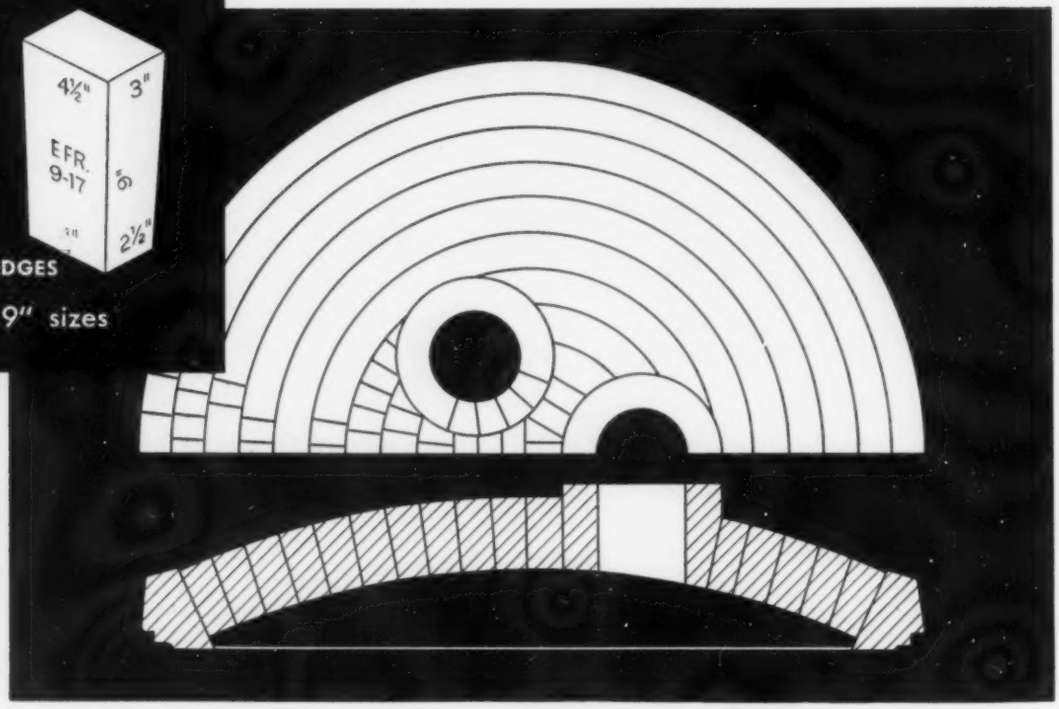
For electric furnace roofs

Harbison-Walker EFR design

provides important benefits



Typical EFR 9" sizes



Harbison-Walker EFR (electric furnace roof) brick are modified 9" key-arches and key-wedges, designed for use in combination with a large proportion of standard 9 x 4½ x 3" sizes in the construction of roofs of any diameter and rise.

The use of these EFR shapes insures a close fit of the brick and roof construction of best workmanship.

The number of different sizes required for building a roof with the aid of the EFR brick is greatly reduced for some designs.

Bricklaying is simplified and much time is saved when EFR brick are used.

EFR brick are power pressed by which method of forming all of the most desirable physical properties are secured.

Roofs built of smaller brick units in preference to large special shapes generally prove to be more serviceable. The smaller sizes are more resistant to thermal shock.

The EFR shapes cost less than large special shapes and since they are used with standard 9" sizes in predominance, the overall cost is considerably reduced.

H-W High Alumina Castable and Korundal Ramming Mix sometimes are used to advantage as a monolith to facilitate easy fitting in the center section.

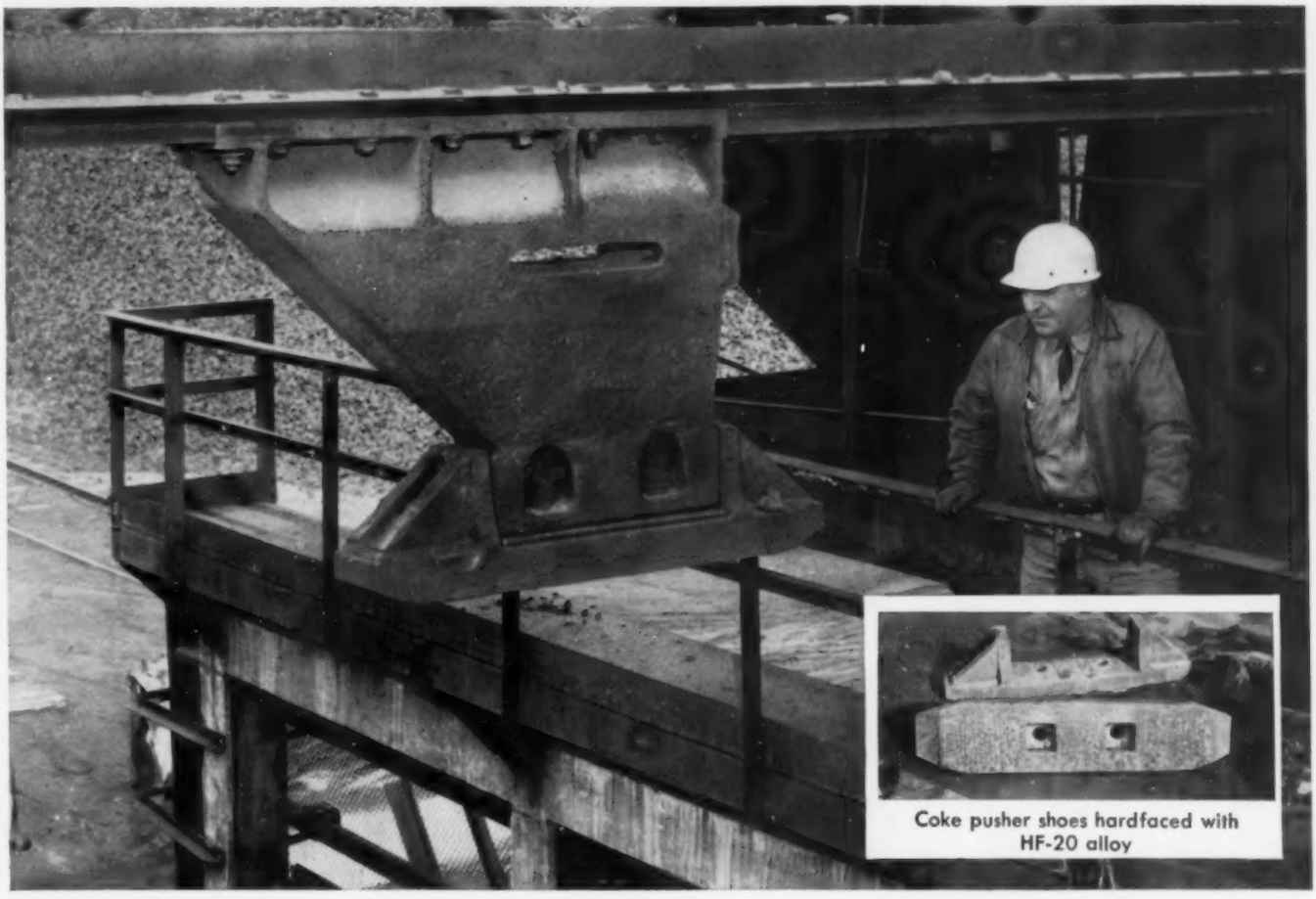
The EFR brick, together with the standard 9" sizes needed for complete roofs, are furnished in the types and classes of refractories best suited for the various operating conditions. For example, they are made in the following brands: STAR and VEGA silica brick; H-W MULLITE; KORUNDAL; and various Harbison-Walker superduty brands, such as ALAMO and H-W SUPER SAVAGE.

The combination of quality, H-W Technical Service and balanced selection based on availability of all types and classes of refractories from one source, provides maximum economy.

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES

World's Most Complete Refractories Service

GENERAL OFFICES: PITTSBURGH 22, PENNSYLVANIA



Coke pusher shoes hardfaced with HF-20 alloy

600% INCREASED SERVICE LIFE

for coke pusher shoes hardfaced with AMSCO® HF-20

At Geneva Works of Columbia-Geneva Steel Division of U. S. Steel Corp., near Salt Lake City, obtaining economical performance from coke pusher shoes had been a problem. The shoes had to be hardfaced or replaced after only three months of use. This meant high maintenance costs and excessive downtime for their coke oven operation.

Their local Amsco distributor, Vern Taylor, suggested that a test be made, using 50 pounds of Amsco HF-20 hardfacing material, or approximately enough to hardface one shoe. The company agreed to his suggestion in an effort to solve their severe wear problem of heat and abrasion.

The coke pusher shoes are steel plate 3¾" wide and 30" long. HF-20 hardfacing, to a depth of ¼" over the shoe surface, was applied for the test.

Test results proved to be more than satisfactory, for Amsco hardfacing *increased service life of the pusher shoes by 600%* . . . or from 3 months to 18 months. Today, hardfacing of coke pusher shoes with Amsco HF-20 is standard procedure at Columbia-Geneva Steel.

This is only one example of the ability of Amsco Hardfacing Materials . . . and Amsco Welding Distributors . . . to help solve wear problems where severe heat, abrasion, corrosion or impact are major factors.

Contact your Amsco Welding Distributor today for information on the full line of Amsco Hardfacing Electrodes and Welding Machines. Or write to American Manganese Steel Division, Welding Products Dept., Chicago Heights, Ill.

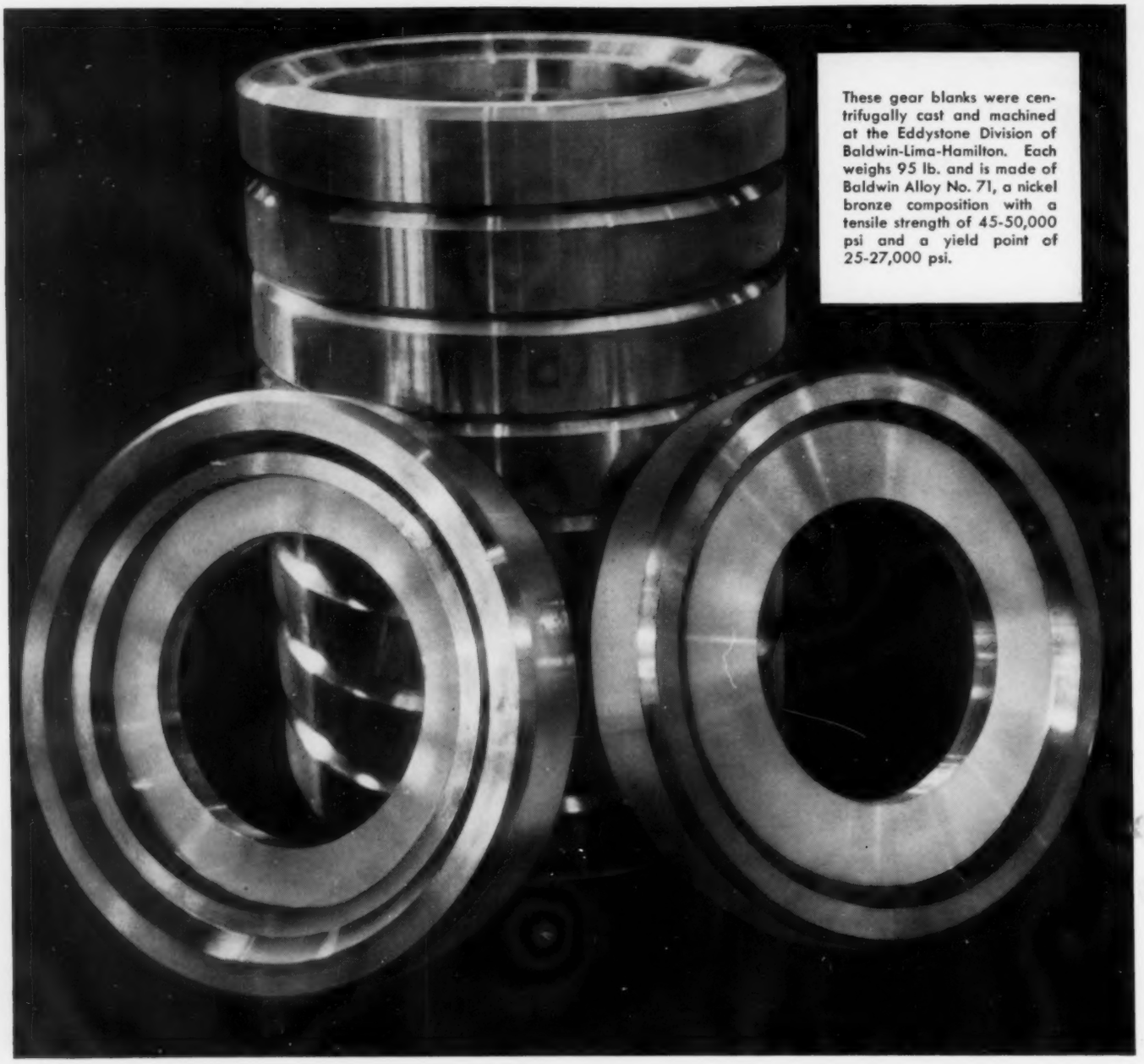
Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.

AMERICAN Brake Shoe COMPANY

AMSCO

American Manganese Steel Division • Chicago Heights, Ill.

OTHER PLANTS IN: DENVER, LOS ANGELES, NEW CASTLE, DEL., OAKLAND, CAL., ST. LOUIS; JOLIETTE, QUEBEC



These gear blanks were centrifugally cast and machined at the Eddystone Division of Baldwin-Lima-Hamilton. Each weighs 95 lb. and is made of Baldwin Alloy No. 71, a nickel bronze composition with a tensile strength of 45-50,000 psi and a yield point of 25-27,000 psi.

Though finish-machined to point of hobbing and drilling, these Baldwin centrifugally cast worm gear blanks **cost no more than rough castings**

When you need a production run of centrifugal castings weighing more than 50 lb. each, Baldwin will cast and finish-machine them to the point of hobbing and drilling, yet charge you no more than for rough castings. And finish-machined gears, since they are so much lighter than rough castings, afford you a substantial saving in shipping expenses. Further, by having Baldwin machine them, you eliminate the possibility of receiving defective gears, for any flaws they might have would be uncovered in the machining operation.

Centrifugal castings are stronger and more durable. The next time you require them, be sure to consult us. We manufacture centrifugally cast blanks in all sizes up to 78 in. in diameter. Write us today for further information. And remember, B-L-H is an excellent source for *all* your foundry needs.

BALDWIN · LIMA · HAMILTON

Eddystone Division

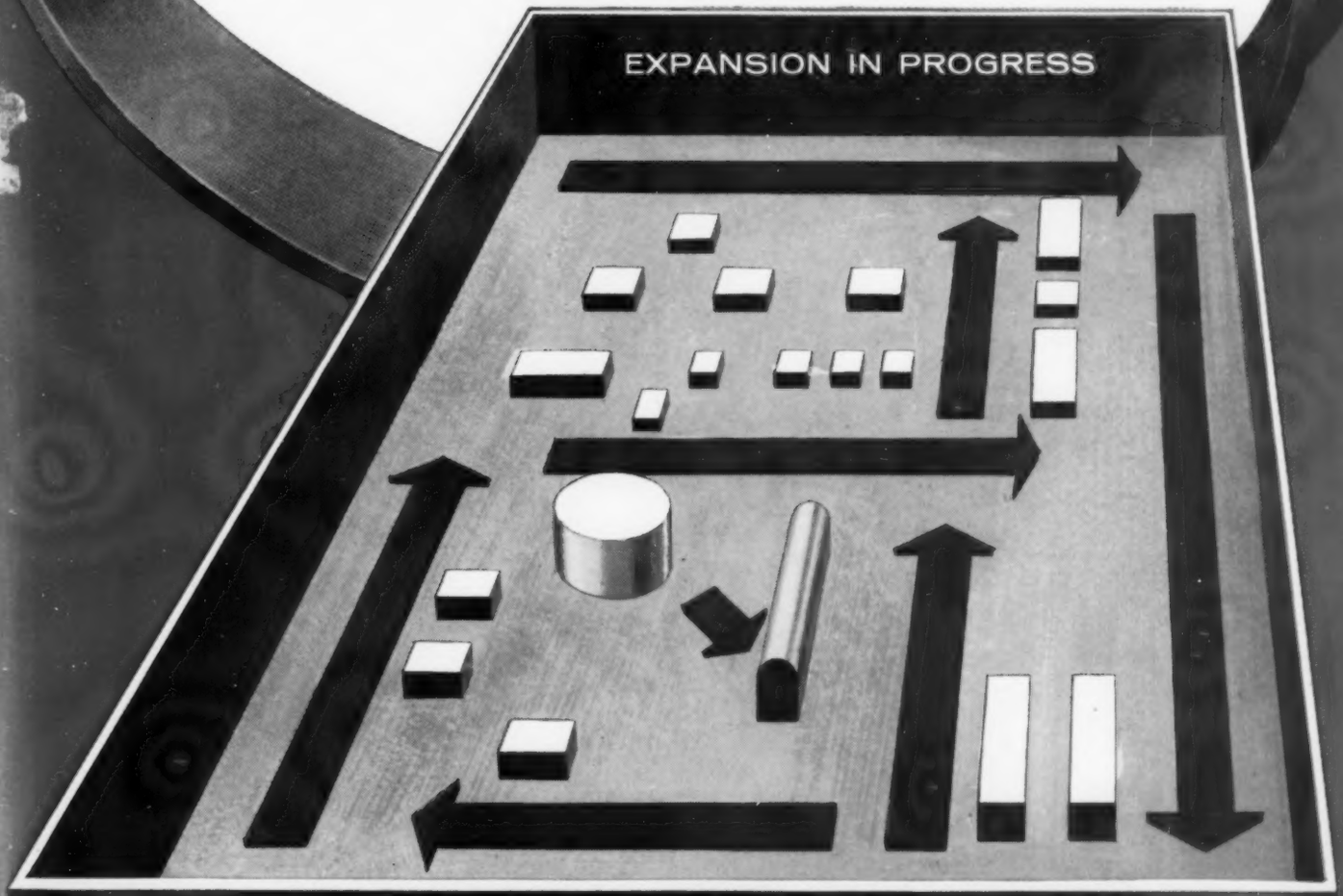
Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings

from planning to full-scale production . . . an outstanding Loewy-Hydropress "turn-key" job

Cooper Alloy Corporation's new plant in Clark, New Jersey, is now at full capacity rolling rings for jet aircraft. Loewy-Hydropress designed the plant, chose the site, supervised construction, specified, procured and installed all machinery and started up operation. So successful were the results that Cooper Alloy has retained Loewy to construct an addition to the plant.

This same integrated Loewy service is available to *you*. For any industrial facility, large or small, Loewy design, engineering and construction know-how can save you time and money . . . help you produce a better product. Write for your copy of illustrated bulletin L-144. Dept. 317, Loewy-Hydropress Division, BLH Corporation, 111 Fifth Avenue, New York 3, N.Y.



BALDWIN BLH LIMA-HAMILTON

LOEWY-HYDROPRESS
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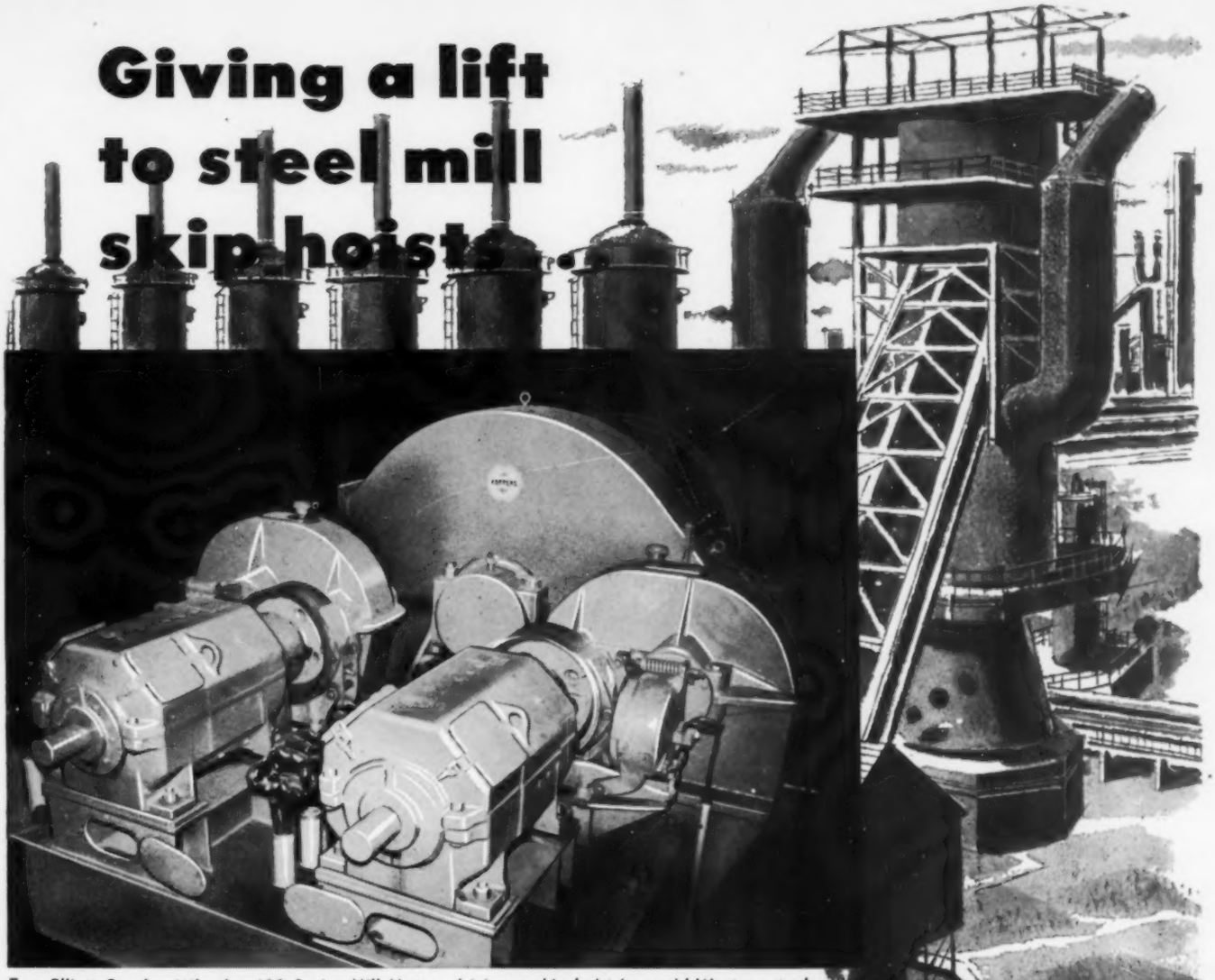
DIVISIONS: Austin-Western • Eddystone • Hamilton • Electronics & Instrumentation • Lima • Madsen • Loewy-Hydropress • Pelton • Standard Steel Works

VICTOR R. BROWNING
MILL TYPE CRANES
to Specification..

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.
WILLOUGHBY (CLEVELAND), OHIO
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

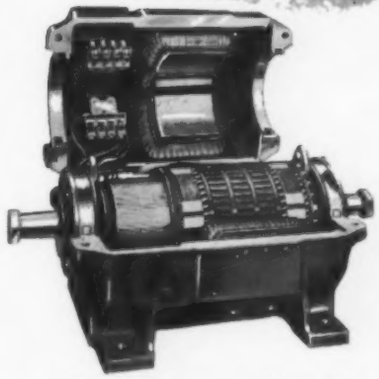
Giving a lift to steel mill skip hoists



Two Elliott Crocker-Wheeler 600 Series Mill Motors driving a skip hoist in a mid-Western steel m

ELLIOTT C-W MILL MOTORS

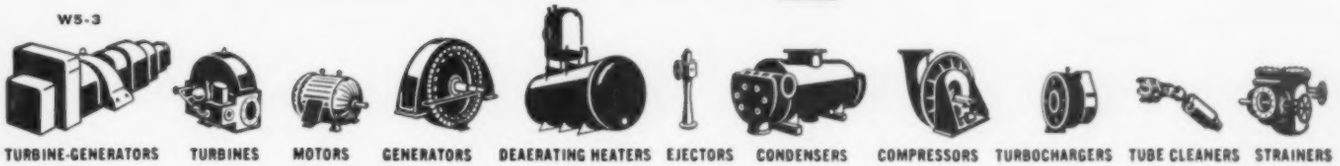
These dependable motors are naturals under rugged, heavy duty operations. They stand up to punishing overloads, constant starting and stopping, reversing strains, etc., and come back for more every time. Their compact durability plus advanced engineering features assure greater power per standard frame size. The tough cast-steel frame is split for easy access to armature, bearings, and field coils. Standard 600 series motors can be readily adapted to separately forced-ventilated, protected self-ventilated or built-in back gear types. For details, ask your local Elliott field engineer, or write for the Mill Motor Bulletin. Address Elliott Company, Crocker-Wheeler Division, Jeannette, Pa.



The split frame is hinged for easy access to all motor parts.

ELLIOTT Company

W5-3



TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

Save by using specialized refractories

Many refractories problems in metal-working furnaces have been solved *economically* by the use of B&W specialized refractory castables. Each ferrous or non-ferrous furnace application requires a specific combination of properties to meet the service conditions. Whether your problem is high temperatures, abrasion and erosion, slag attack or the need for insulation, to name a few, you will find the refractory castable best suited to your requirements in B&W's line. Shown here in digest form are data on the widely used B&W refractory castables for metal-working furnaces:

B&W Refractory Castables for Metal Working Furnaces

	Temp. F	PROPERTIES	TYPICAL APPLICATIONS
B&W Kaocast	3000	High resistance to spalling and slag attack. Low volume change and negligible reheat shrinkage.	Soaking pit covers, linings of high temperature heating and forging furnaces, burner blocks, electrode linings of electric furnace roofs, linings of non-ferrous metal furnaces.
B&W Kaocrete 32	3200	High strength, exceptional refractoriness, unusual volume stability, excellent resistance to spalling.	Can be used in applications similar to those of B&W Kaocast and where higher refractoriness is required.
B&W Kaocrete D	2500	Sufficient strength and hardness to withstand abrasion, considerable physical abuse and erosion.	Aluminum melting furnaces, linings and car tops in heat treating furnaces, as well as in sections of a wide variety of furnaces that are subject to scraping by hand tools or other mechanical abuse.
B&W Kaocrete A	2600	Resists reducing atmospheres. Has good resistance to erosion, abrasion and thermal shock.	Annealing furnace bases and other applications where resistance to reducing atmospheres is essential. Also as a general purpose castable for linings in medium temperature service.
B&W Kaocrete B	2300	Has an adhesive plastic texture particularly suited for vertical or overhanging constructions. Excellent for plastering.	Patching linings and baffles and for any application where plastering rather than gunning or casting is required.
B&W Kaocrete LI	2700	High alumina content, exceptionally high strength for resistance to abrasion and erosion.	Aluminum furnace linings where high alumina content is important.
B&W Kaolite 20	2000	Offers castable's fast, low cost installation plus insulation. Has refractoriness, light weight and low heat conductivity and, in addition, will resist reducing atmospheres. Can be poured or gunned.	Aluminum melting, heating and heat-treating, annealing and forge furnaces. Also for general maintenance and patching.
B&W Kaolite 22	2200	Has the same properties as B&W Kaolite 20. Can be used for higher temperatures but not in reducing atmospheres.	

Send for your copy of B&W Bulletin R-35. It gives additional information on B&W's versatile refractory castables.

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

R561

The man with the diamond

The bouncing diamond-pointed weight of the Shore Scleroscope shows its skilled operator whether the hardness of this mill roll's surface meets the specifications of its purchaser. Failure to pass this test is rare at Mack-Hemp; our long experience in roll making . . . one hundred and thirty-four years of it . . . has made the close control of every production step second nature to us, from pattern making to final testing. It is one of the many reasons why *you get more tonnage from the rolls with the Striped Red Wabblers.*

MACKINTOSH-HEMPHILL
Division of E. W. BLISS Company
Pittsburgh and Midland, Pa.

MACKINTOSH-HEMPHILL DIVISION · PITTSBURGH · U.S.A.

BLISS

DATA ON VOLMEX 81 . . .

HOW VOLMEX® 81

performs as a high volatile ingot mold coating when applied . . .

(1) Wet (2) Dry (3) At varying ingot mold temperatures

VOLMEX 81 is a highly volatile ingot mold coating which has been tested and adopted by a number of steel plants. The charts below are based on actual data obtained during such trial runs. Because of the differing practices employed by various companies, we have included several variables. First, because VOLMEX 81 can be applied either dry or with water as the carrier (spraying, swabbing or dipping are all practical), we have presented test figures on its use, both wet and dry. Second, we have included data on a range of ingot mold temperatures from 100°F. to 700°F., and third, we offer for comparison the results of a one-hour and a three-hour time-at-mold temperatures. No matter what method of application was used, VOLMEX 81 was found to repel metal splashes effectively before they could solidify and cling to the mold wall. At the same time, enough of the graphite-base coating was left at the metal/mold interface to keep the main body of the pour from clinging when it reached the point of splash, thus reducing surface defects. For wet application, VOLMEX 81 is easily stirred into suspension and remains in that state for hours without re-agitation.

VOLMEX 81 is the most volatile of the United States Graphite Company ingot mold washes. Others, in order of their volatility are: 90-B (non-volatile), MEX (very little volatility), and VOLMEX (volatile, but less so than VOLMEX 81). Write us for more extensive details or our engineering staff is available for on-the-spot assistance. Mold spray and mixing equipment are ready for your use in tests you may want to arrange.

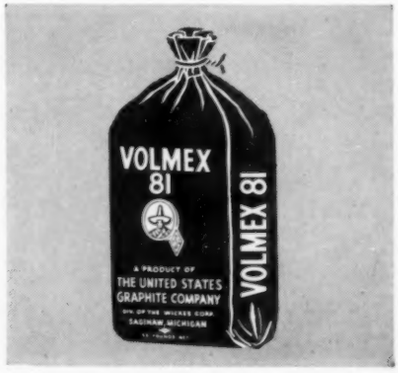


Table I **Volatility of VOLMEX 81 Ingot Mold Wash**

Mold Coating Volatility Test—VOLMEX 81 Water Application 2.75 lbs. powder/gal. water—Period—1 Hour at	Temperature 300°F.	500°F.	700°F.
% loss after heating for 1 hour	74.3	73.9	75.4
% loss on ignition at 1900°F. after 1 hour at specified temperature	16.1	14.4	11.3
Total percent volatile matter	90.4	88.3	86.7

Table II

Mold Coating Volatility Test—VOLMEX 81 Dry Application—Period—1 Hour at	Temperature 100°F.	300°F.	500°F.	700°F.
% loss after heating for 1 hour	0.1	0.8	0.9	2.8
% loss on ignition at 1900° F. after 1 hour at specified temperature	60.8	60.4	59.7	56.5
Total percent volatile matter	60.9	61.2	60.6	59.3

Table III

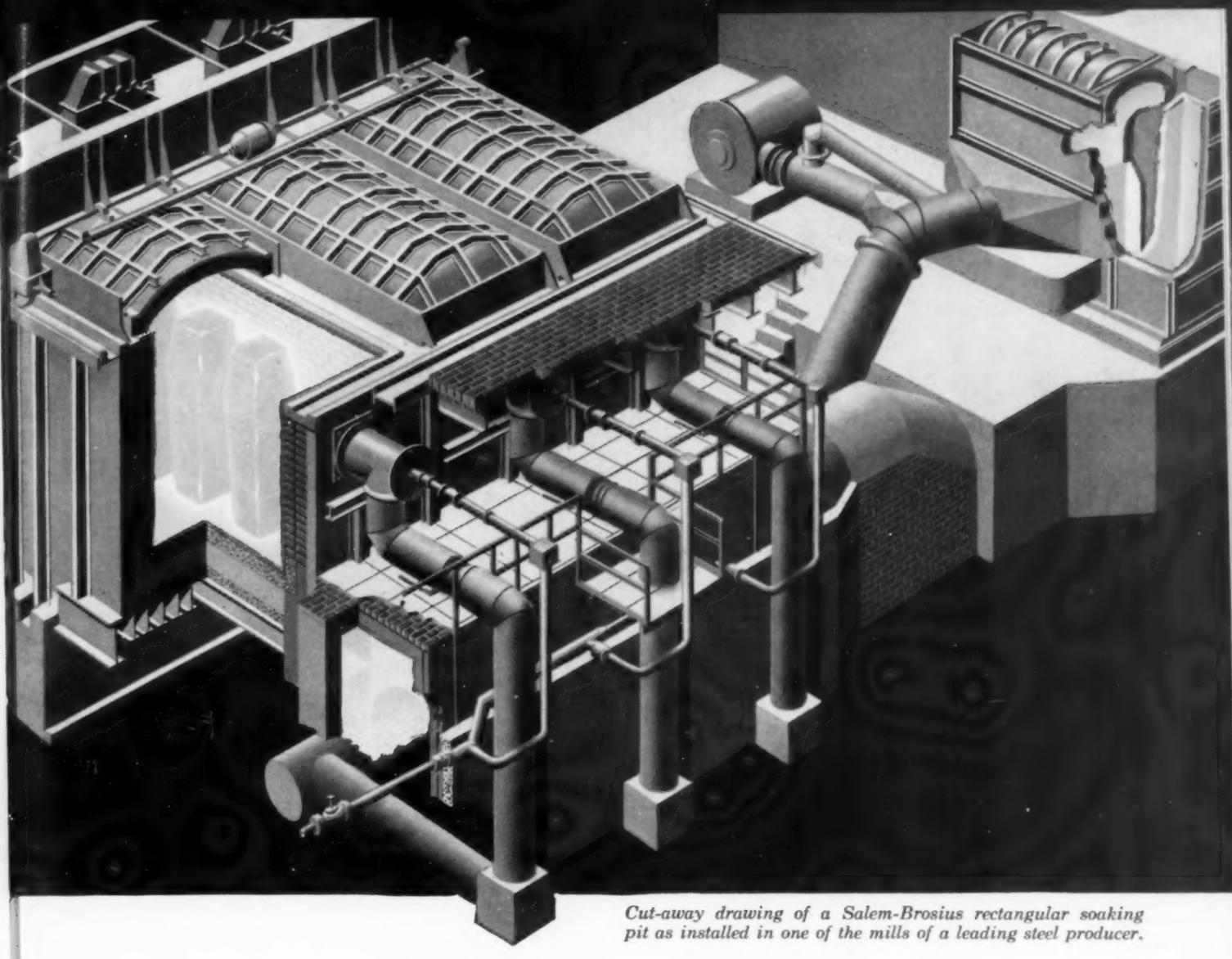
Mold Coating Volatility Test—VOLMEX 81 Dry Application—Period—3 Hours at	Temperature 100°F.	300°F.	500°F.	700°F.
% loss after heating for 3 hours	0.1	0.8	1.1	4.5
% loss on ignition at 1900°F. after 3 hours at specified temperature	60.6	59.6	59.7	53.1
Total percent volatile matter	60.7	60.4	60.8	57.6

You will note in the first chart which is the wet application, that the loss is all of the water contained plus a slight amount of the remaining volatile. Since on a weight basis, the powder is about ¼ of the make-up, if you will multiply the percent loss figures at 1900°F. by four, you will get an idea of the amount of volatile which would be present for loss during the pouring operation.

217

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW 9, MICHIGAN



Cut-away drawing of a Salem-Brosius rectangular soaking pit as installed in one of the mills of a leading steel producer.

Users are the best salesmen of Salem-Brosius soaking pits

"We have again specified Salem-Brosius rectangular soaking pits for our expansion program," reports an operating official of a major steel company using pits installed by several manufacturers. "The previous installation heated more steel ingots ready for rolling with less fuel consumption, less maintenance cost, and better temperature uniformity than any other type of pit in our plant."

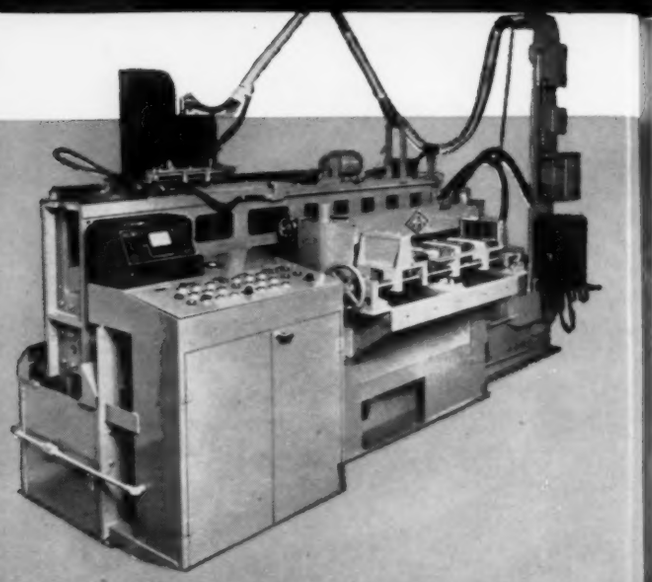
Reports like this are typical, not only about these rectangular soaking pits, but all other Salem-Brosius heating and heat-treating furnaces as well. Salem-Brosius engineers, both here and abroad, possess an enviable record for designing furnaces which produce maximum, high-quality output at minimum operating cost. If your expansion or modernization plans call for ingot soaking pits or any other heating or heat-treating furnaces, Salem-Brosius, Inc. would appreciate an inquiry.

SALEM-BROSIUS, INC.

CARNEGIE, PENNSYLVANIA

In Canada: Salem Engineering Limited, 1525 Bloor Street West, Toronto, Ontario

THE NEW MPM Shear Welder



CONTINUOUS SILICON SHEET PRODUCTION

Shearwelder for coil build up line for 42" wide Silicon Steel from .015" to .030" thick.

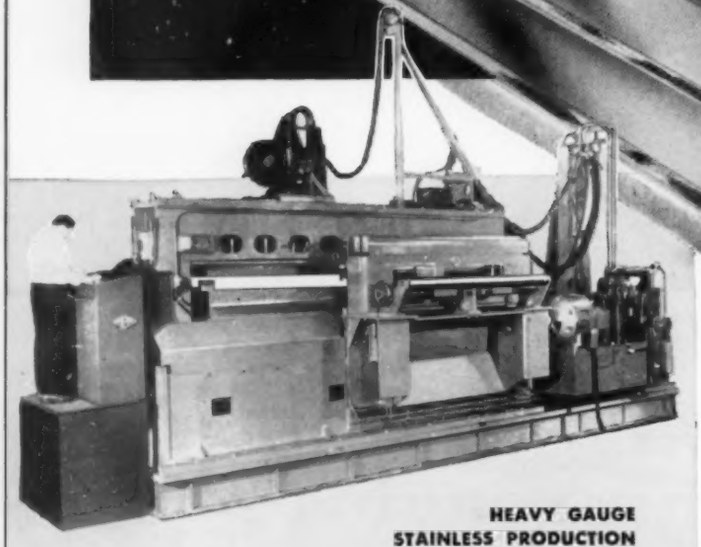
.....more automation for even faster Steel Production!

● Metal Processing Machine Company's new Shearwelders are outstanding because of their advanced design incorporating automatically sequenced operations.

Shearing and welding are performed at the same station with positive clamping right at the work area, thereby insuring perfectly aligned butt welds.

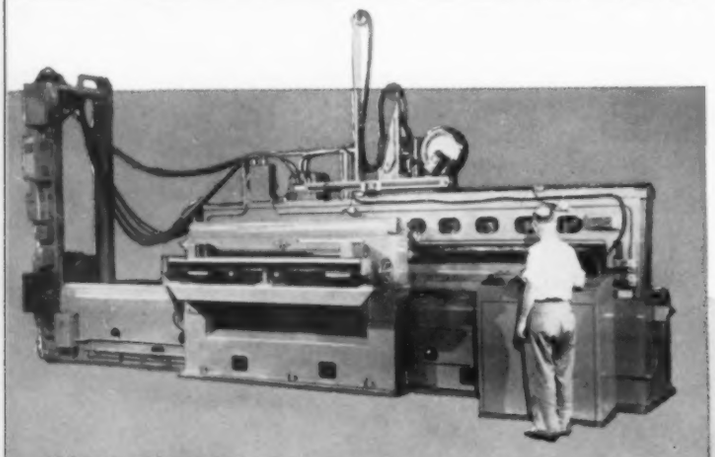
"M.P.M." welds are **extremely ductile,** permitting subsequent rolling, forming, or blanking operations. Weld joints are smooth and require **no trimming.**

Rugged construction is insurance for minimum maintenance and compact design saves floor space.



HEAVY GAUGE STAINLESS PRODUCTION

Shearwelder for butt welding 60" wide x .250" thick Stainless Steel.

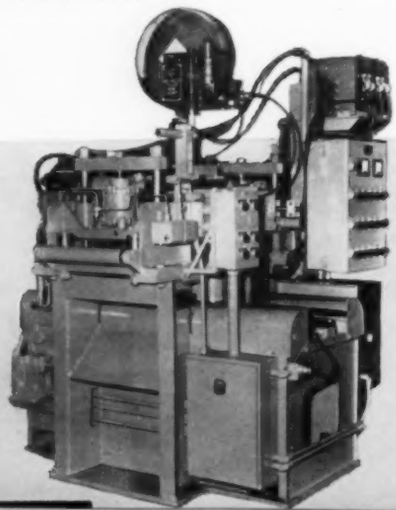


MAJOR COIL BUILD UP

Shearwelder for Carbon Steel coil build up line for .015" to .060" thick x 72" maximum width.

THE METAL PROCESSING MACHINE CO.

SUBSIDIARY OF McKAY MACHINE CO.
YOUNGSTOWN, OHIO



MPM

CONTINUOUS TUBE MILL PRODUCTION

Shearwelder used with strip looping device for splicing coil to coil to permit continuous production of tube mill.

10065

How to simplify control problems

Keep systems flexible, carry small inventory, cut maintenance cost with the **Bailey Building Block Method** of instrumentation and control.

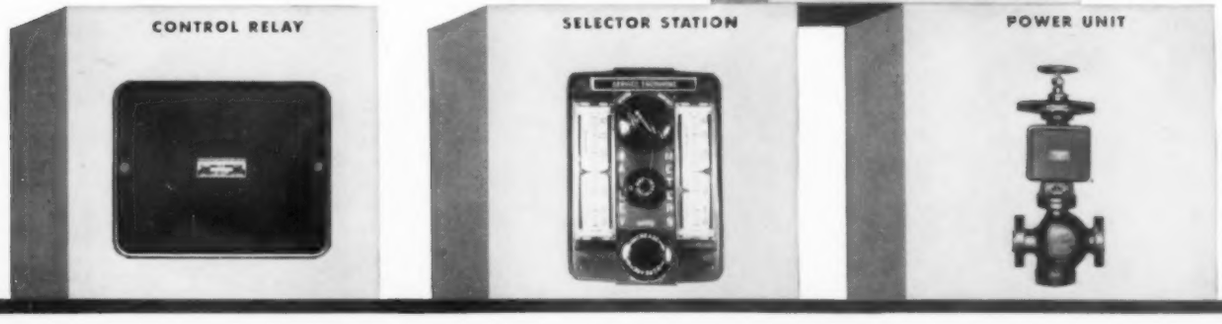
What is the Bailey Building Block Method? It's using standardized Bailey measuring, transmitting, and controlling components and combining them into any system you need. Components can be added as needed . . . removed and reused elsewhere . . . recombined into another system when the need changes. It's flexibility plus!

It's all based on the simple fact that a Bailey instrument or control component doesn't care if the measured variable is fuel flow, percent oxygen, or furnace temperature, to pick just three examples. System components—transmitters, receivers, relays, selector stations, power units—are standardized for multi-purpose use.

A spare component can be used in any one of many systems. Gone are delays waiting for shipments of special parts. Gone are large inventories of spares and parts. Simplified is the training of men for maintenance.

There are many exclusive features and advantages of the individual components used in the Bailey Building Block Method. And there's much more to the Building Block story itself.

For further details, write to our Iron & Steel Division. Our engineers will be glad to prove how the Building Block approach will save you money and simplify your instrument and control problems.



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BAILEY METER COMPANY

IRON AND STEEL DIV., 1047 IVANHOE ROAD, CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

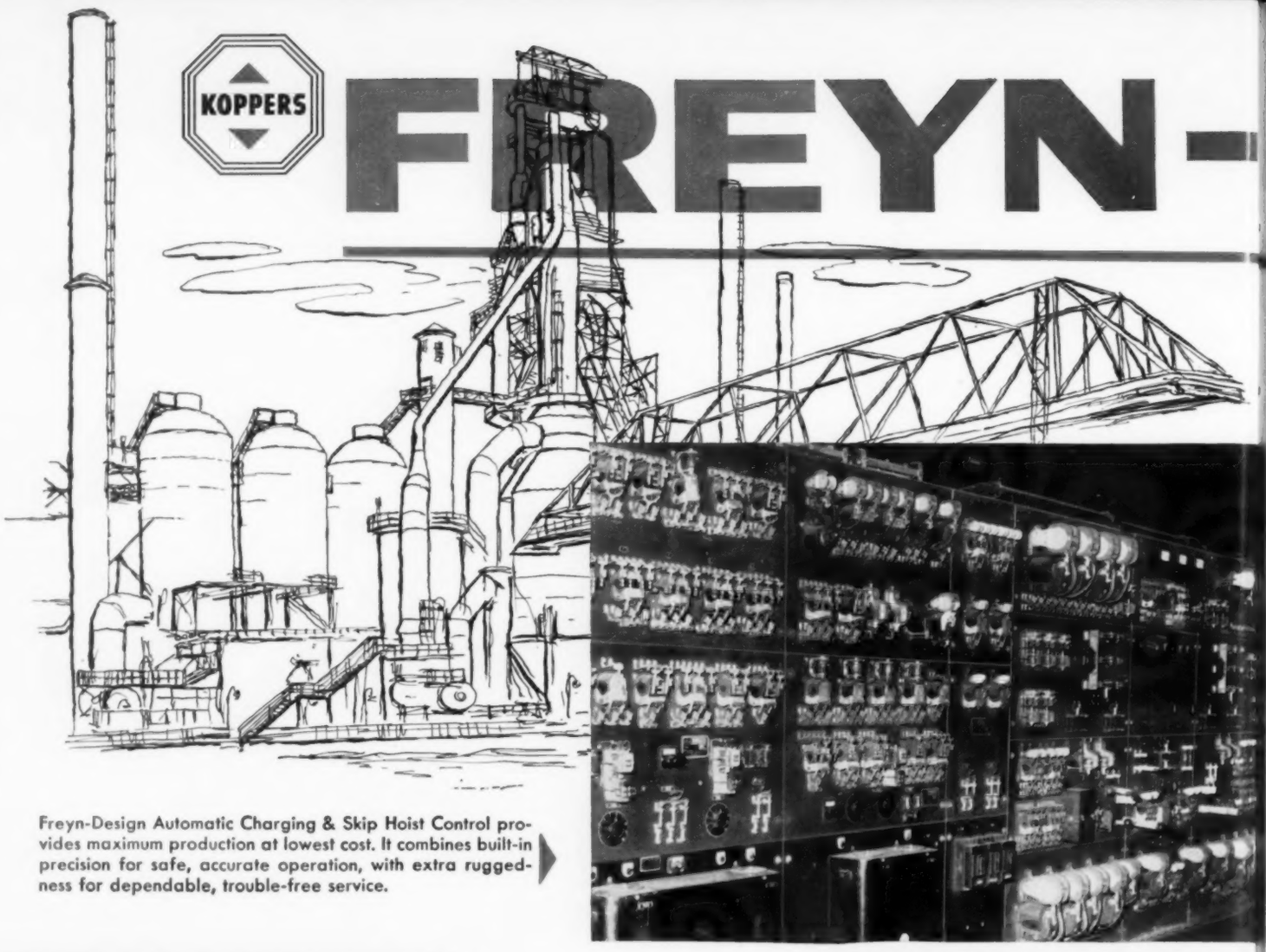
BAILEY BUILDING BLOCK METHOD

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

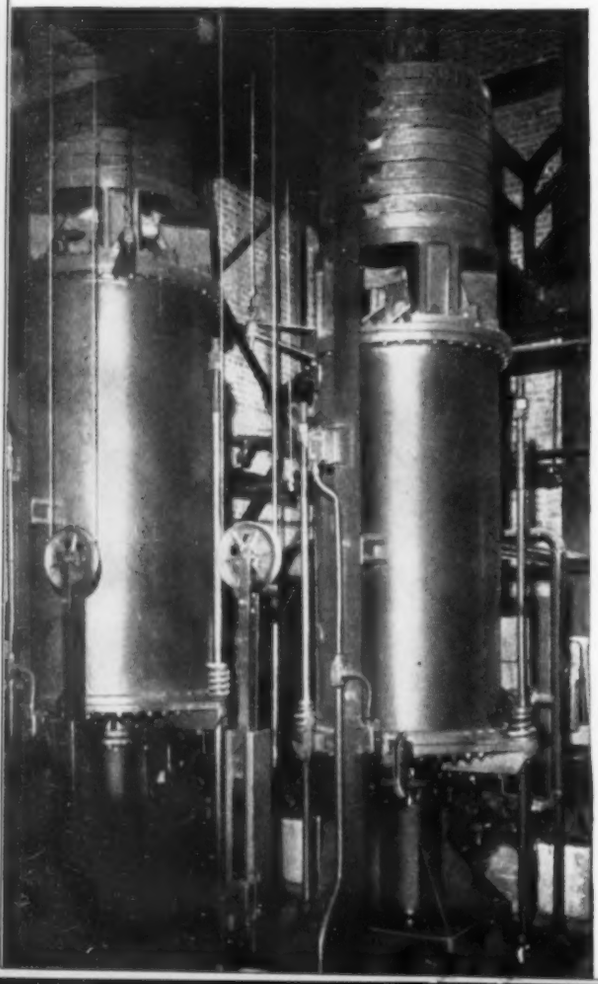
BAILEY METERS

KOPPERS

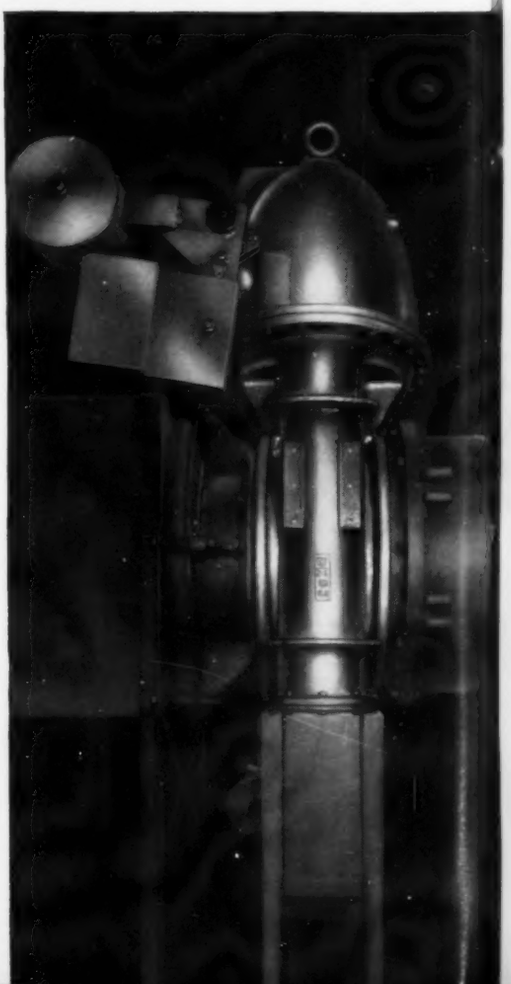
FREYN-



Freyn-Design Automatic Charging & Skip Hoist Control provides maximum production at lowest cost. It combines built-in precision for safe, accurate operation, with extra ruggedness for dependable, trouble-free service.



Freyn-Jansen Burner Shut-Off Valve replaces the conventional burner door in hot blast stove installations. It increases the speed and safety of burner changing operations, eliminates refractory and gasket maintenance.



Freyn-Design Pneumatic Bell Hoist is engineered to provide long life with little maintenance. It uses cold blast air—the least expensive, most dependable operating power at the blast furnace.

DESIGN

the standard of performance in blast furnace equipment

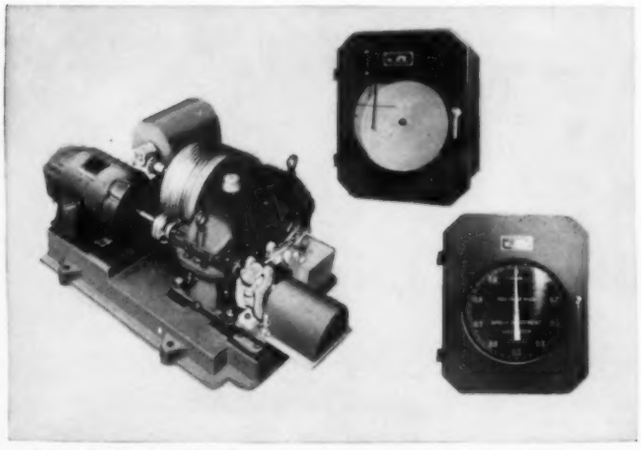
There are many sound reasons for Freyn's continued leadership in the design and construction of equipment for blast furnace operations. Freyn provides the *most complete* line of blast furnace equipment. And blast furnace operators throughout the world *know* that with Freyn equipment they get these important advantages:

. . . **unequalled performance:** Freyn quality and performance are based on more than 40 years of experience—not only in blast furnace equipment, but in the design and construction of *complete* blast furnace and open hearth installations.

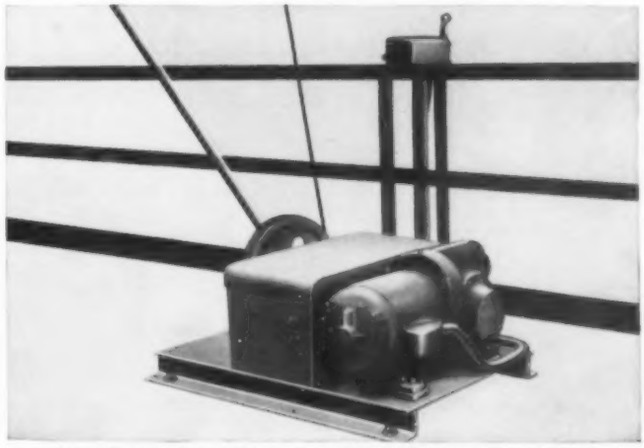
. . . **minimum maintenance:** Freyn equipment is designed, engineered and built to withstand punishing everyday operation—saves man hours, reduces costly delays due to breakdowns.

. . . **maximum economy:** Operating costs are kept at a minimum, production at a maximum.

Investigate the long range reliability and economy of Freyn-Design blast furnace equipment for your operations. Send for information on Freyn equipment or consult our engineers. **Freyn Department, Koppers Company, Inc., Pittsburgh 19, Pa.**



Freyn-Design Stockline Recorder gives accurate, automatic blast furnace stock level measurement: winch mechanism hoists and lowers test rod, actuates indicating and recording devices; recording meter records actual stock level on chart; stock movement visualizer magnifies and indicates frequency of burden movement; lamp target indicator shows stock level at all times, mounts in stock and/or cast house.



Freyn-Design Motor Driven Snort Valve Operator permits fast operation for any blast furnace snort valve. In the event of electrical power failure, the manual handwheel becomes operative immediately.

CHARGING CONTROL • STOVE CHANGING EQUIPMENT • PNEUMATIC BELL HOIST • STOCKLINE RECORDER • SKIP HOIST MOTOR DRIVEN SNORT VALVE OPERATOR • BURNER SHUT-OFF VALVE • PNEUMATIC SLUDGE EJECTOR • HIGH PRESSURE EQUIPMENT • STOVE PRESSURE BURNERS • VALVES

KOPPERS®

KOPPERS COMPANY, INC.

FREYN DEPARTMENT

ENGINEERING AND CONSTRUCTION DIVISION

2 High Hot Strip Mill Table Rolls in plant of Dominion Foundries and Steel Ltd., Hamilton, Ontario, Canada. Arrows indicate location of J-M Clipper Oil Seals which protect bearings against dirt and other adverse conditions.

Engineers at Dominion Foundries and Steel Hot Strip Mill report:

"Bearings better protected— damaging dirt sealed out with Clipper Seals"

TABLE ROLLS of the 2 high strip mill at Dominion Foundries and Steel Ltd. must operate efficiently despite severe service conditions. Life of the Roll Bearings is constantly threatened by dirt and salt from strip mill operations.

To provide better protection, engineers replaced the original bearing seals with J-M Clipper Oil Seals. Long after this installation was made, Clipper Oil Seals are still providing far better bearing protection than the material formerly used. They seal out mill scale, salt and other foreign matter which might work into the bearing housings. They remain efficient despite high oil and air temperatures. They protect bearings by assuring clean lubrication.

Clipper Oil Seals offer many advantages wherever accurate fit, longer life and greater sealing effectiveness are required. These precision-moulded oil seals provide easy installation because the tough, dense heel affords just the right amount of rigidity for a press fit in the cavity . . . while the flexible lip, held in light but positive contact with the shaft by an especially designed garter spring, provides effective sealing at all times.

Made in both split and endless types, Clipper Oil Seals are available in a wide variety of designs, to meet practically any sealing requirement. For complete details and literature write Johns-Manville, Box 14, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER OIL SEALS

Helpful Data from
DE LAVAL

How to calculate the efficiency of worm gearing

The efficiency of worm gearing is determined by frictional losses at the tooth contact, bearings and oil seals plus losses from oil churning and windage. A formula for efficiency at the tooth contact may be developed from a consideration of the forces at the contact. Figure 1 shows these forces acting on a developed section of the worm thread. For simplicity the pressure angle has been assumed to be zero.

The coefficient of friction of the worm and gear is a function of the materials, finish, lubrication and rubbing speed. The latter is the relative speed between a point on the pitch surface of the gear and one on the pitch surface of the worm. The coefficient of friction varies very little at high rubbing speeds but rises with increasing rapidity as the speed drops below 500 fpm.

The efficiency formula developed in Figure 1 involves worm lead angle and the friction angle. Figure 2 provides a relationship between friction angle and rubbing speed based on tests made on accurately manufactured gearing consisting of hardened and ground worm and bronze gear operating in oil.

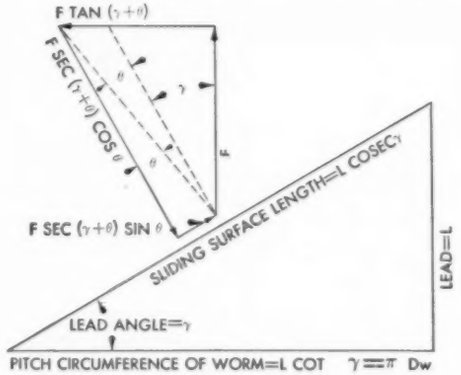
The formula for rubbing speed is:

$$V = \frac{.262\ Dw \times \eta}{\cos \gamma}$$

where

$V =$ Rubbing speed – feet per minute
$Dw =$ Worm pitch diameter – inches
$\eta =$ Worm speed – rpm
$\gamma =$ Worm lead angle

FIGURE 1.
Development of equation for efficiency at contact between worm and gear



F=TANGENTIAL FORCE ACTING ON GEAR

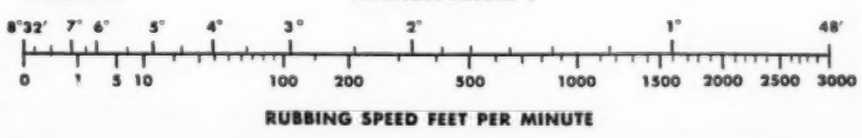
F TAN ($\gamma + \theta$) = TANGENTIAL FORCE APPLIED TO WORM

F SEC ($\gamma + \theta$) COS θ = FORCE NORMAL TO CONTACT SURFACE

F SEC ($\gamma + \theta$) SIN θ = FRICTIONAL FORCE

$$\text{EFFICIENCY} = \frac{\text{WORK REALIZED}}{\text{WORK APPLIED}} = \frac{L \times F}{L \cot \gamma \times F \tan (\gamma+\theta)} = \frac{\tan \gamma}{\tan (\gamma+\theta)}$$

FIGURE 2.



DE LAVAL Worm Gear Speed Reducers Offer Efficiencies to 96%

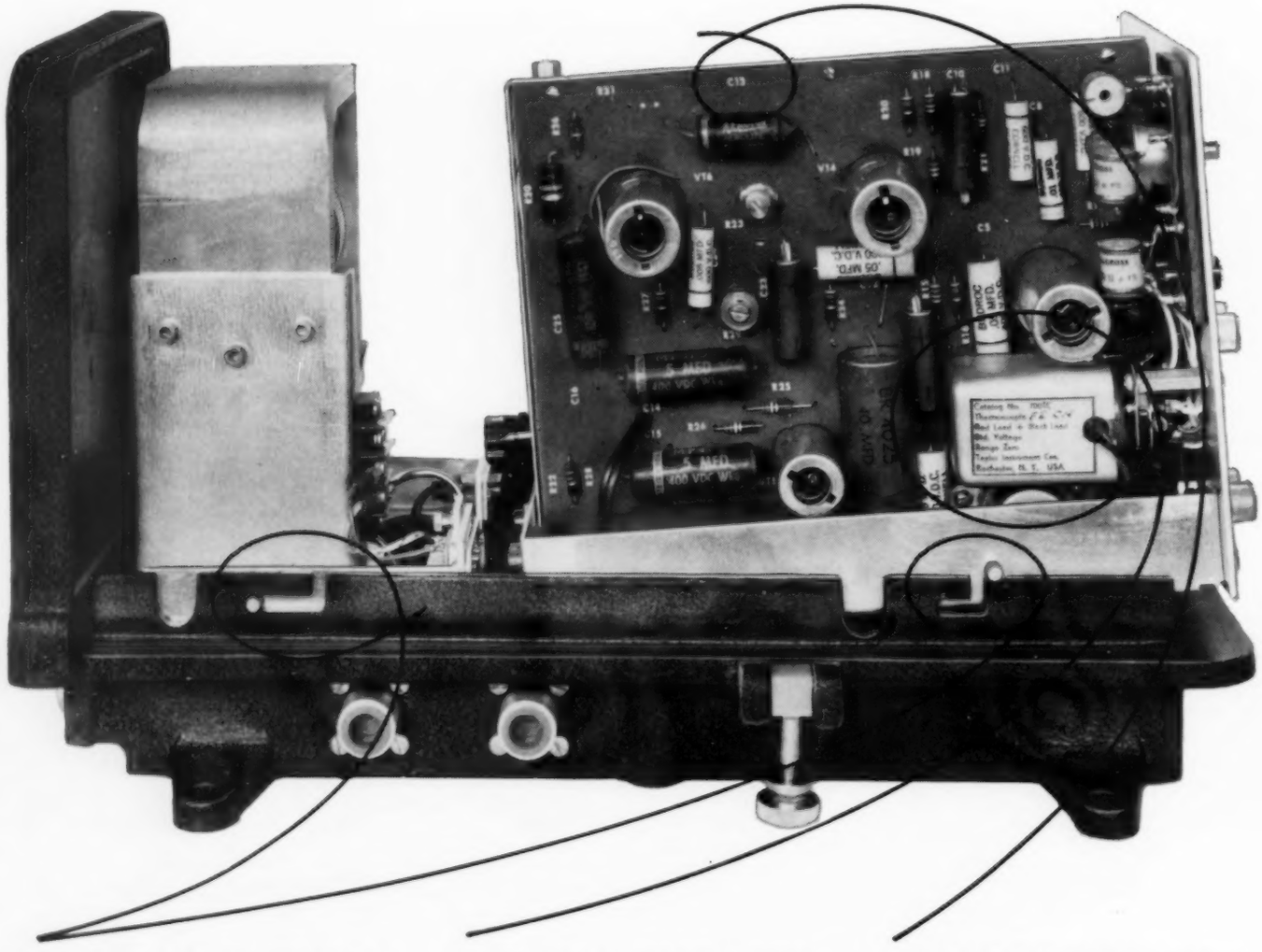
Ruggedly built for long efficient service De Laval speed reducers are made in horizontal and vertical single reduction units in ratios of 3:1 to 100:1. They are also available in double horizontal and vertical double reduction units as well as in helical-worm and double-worm design. Ratios from 37.8:1 up to 6400:1.

Write for your copies of Catalogs G-WBV and G-WWH to De Laval Steam Turbine Company, Trenton 2, New Jersey.

IN STRAIGHT LANGUAGE...

Why a Taylor Potentio-

Converts any primary electrical signal into a 3-15 psi. pneumatic output for controllers and receivers



PLUG IN the Transducer and the Amplifier—an exclusive with Taylor! Gives you quick, easy removal for service with minimum instrument down-time . . . means that checking can be done efficiently in the shop where full facilities are available.

PLUG IN CANS for simple service changes. Adapts quickly for use with different primary elements by simply plugging in the corresponding service "can". Note—for thermocouple applications cold junction compensation is provided in the plug-in can.

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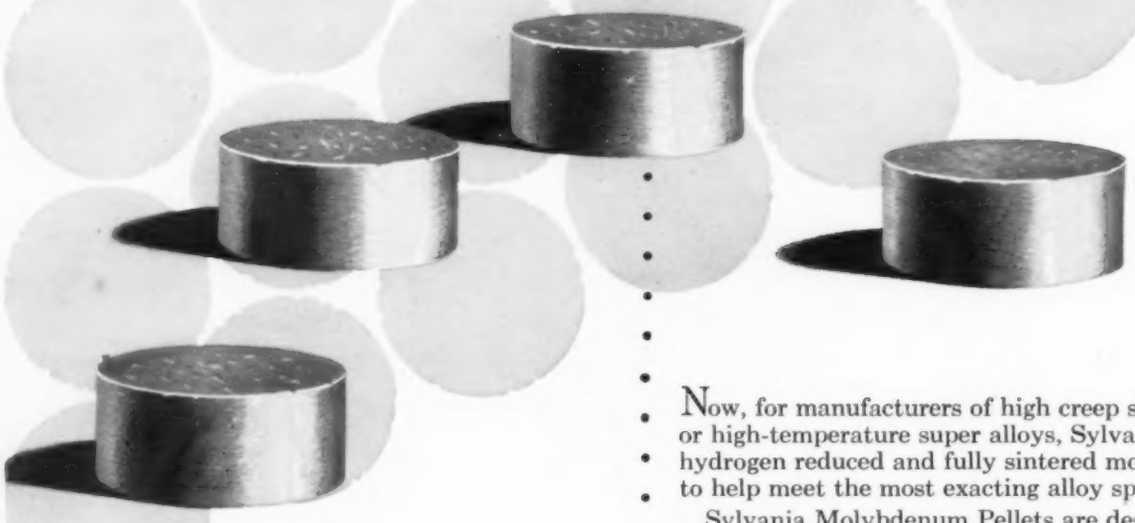

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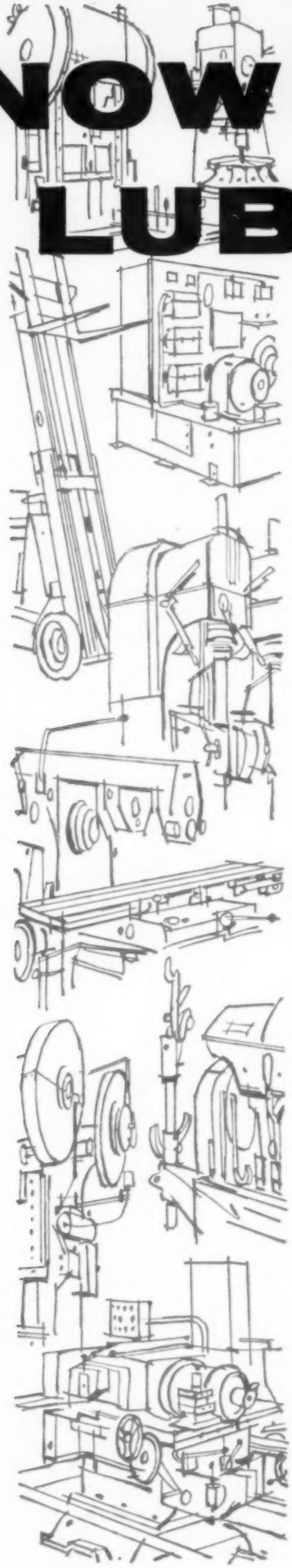

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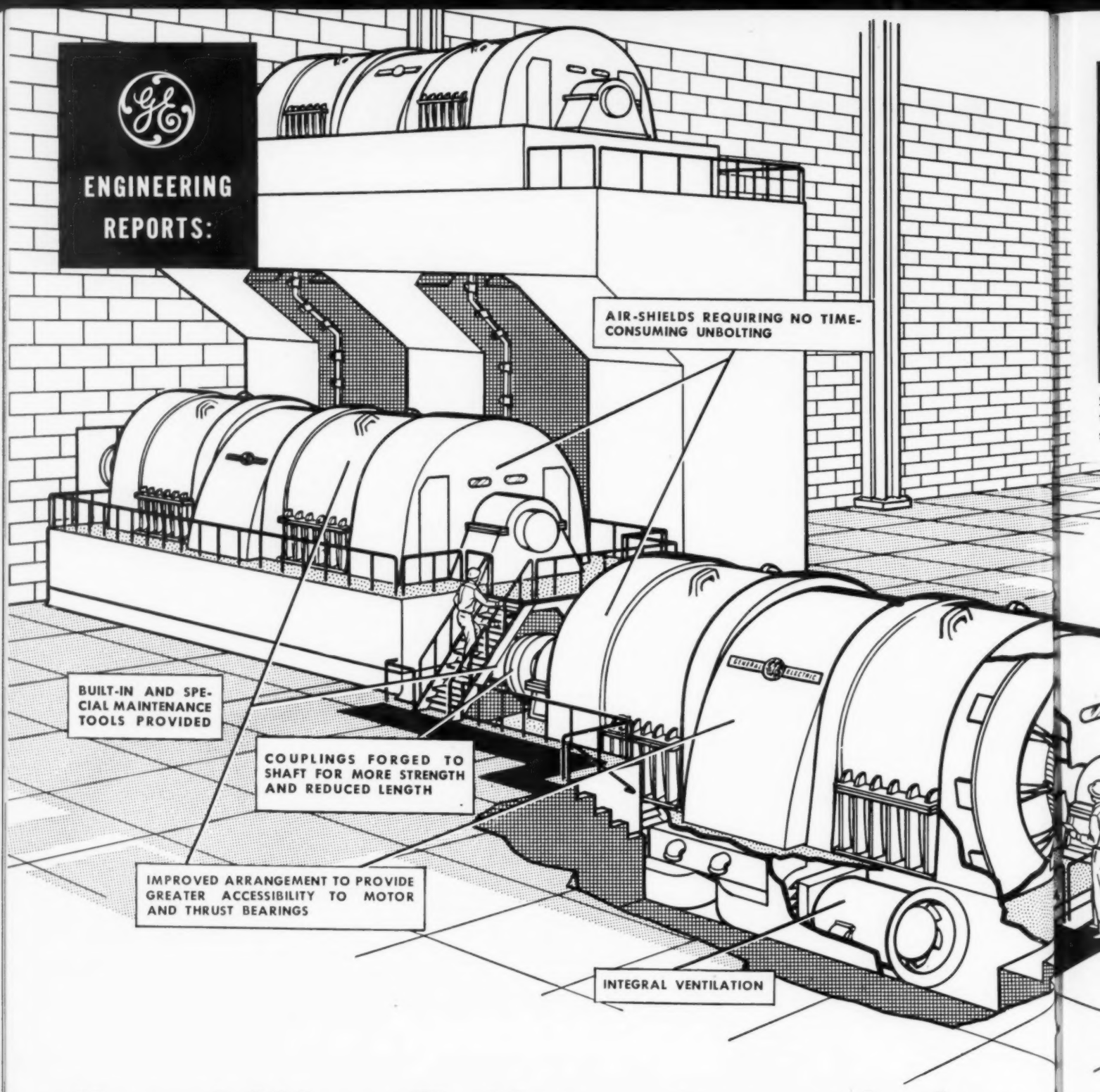
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INTEGRAL VENTILATION

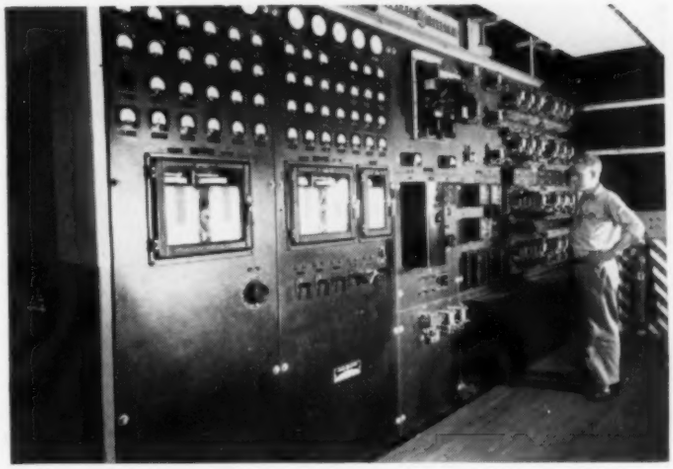
New slabbing-mill drive system emphasizes

General Electric d-c drive system for new slabbing mills will have unique design features

SPIRALING OPERATING COSTS and increasing capital requirements for equipment throughout the steel industry have brought about a restudy of conventional construction practices and maintenance problems. The General Electric Company, recognizing the requirements of this basic and fast growing industry, undertook additional comprehensive studies of system design and drive construction. This was done to simplify and reduce electrical maintenance, and lower initial capital investment, through reduced construction costs.

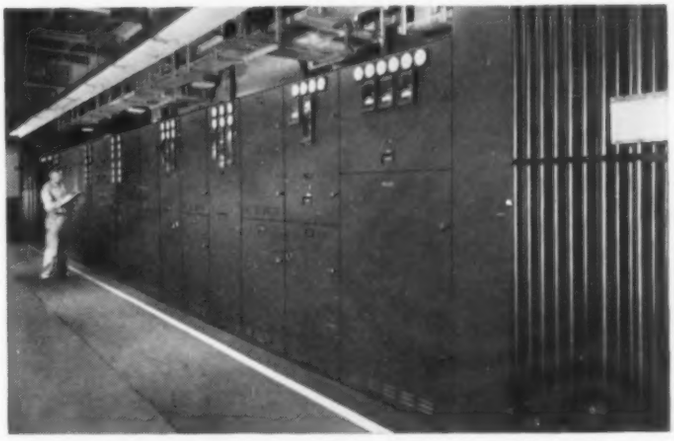
NEWEST HIGHLIGHTS of the design study, as now being furnished on General Electric engineered electrical systems for slabbing mills, are shown above. These unique design features will permit easier "productive maintenance" (by simplifying and reducing maintenance requirements) and minimize production stoppages. Some of the new main-drive design features are:

- **Integral ventilation**
- **Improved twin drive arrangement**
- **Forged flange couplings**
- **Quickly removable air-shields**
- **Built-in and special maintenance tools**

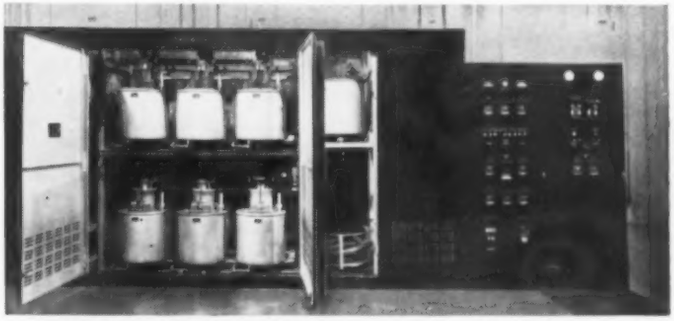


SYSTEM ENGINEERING co-ordinates electrical system by centralizing control functions for mill in master control panel. Instrument panel provides production picture at a glance.

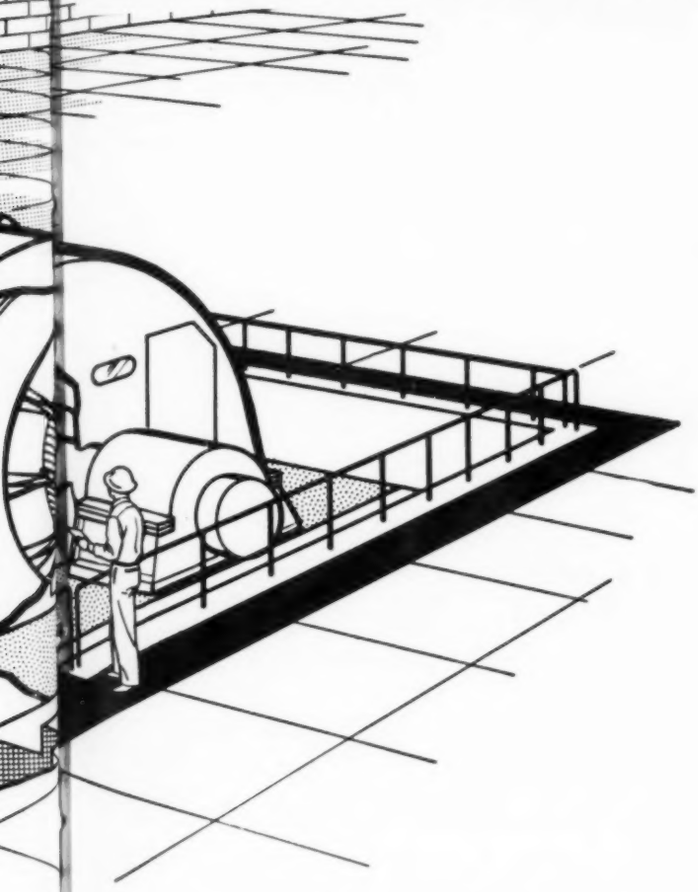
ENCLOSED General Electric flywheel, induction-motor-generator set provides direct current for the huge slabbing-mill drive motors with minimum load swing on power system of the mill.



INCOMING POWER is distributed through General Electric double-ended unit substation. Magne-blast power circuit breakers provide excellent service entrance and feeder protection.



LOWER INSTALLATION COSTS are possible with unit substation arrangement of G-E pumpless rectifiers. Pumpless stainless steel tanks, twin ignitors (1 spare) mean more dependable service.



reduced maintenance

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.... a number of unusual details feature the new rod mill at Bethlehem's Johnstown plant .... air and water are used for cooling .... scale loss and acid consumption have been reduced .... surface of drawn wire has been improved ....

NEW ROD MILL At Bethlehem's Johnstown Plant

By
J. C. SEIBERT
Superintendent
Rod and Wire Div.
Bethlehem Steel Co.
Johnstown, Pa.

▲ THE Johnstown rod mill is a complete modern high-speed mill designed for rolling rod coils in sizes $\frac{7}{32}$ to $\frac{3}{4}$-in. diam. Figure 1 gives the general plan of the rod mill.

The mill consists of 23 stands driven by 11 motors, with the line of the mill going through two 180-degree repeaters. The "B" line (two-strand operation), rolls rod $\frac{7}{16}$ in. and larger through the first repeater (15 stands) and into four pouring reels. The "A" line, (three-strand operation), rolls rod $\frac{7}{16}$ in. and smaller through the entire mill and into six laying reels. A 274-hook, 1638 ft long, monorail-type hook conveyor transfers rod from both sets of reels to the rod-storage dock.

The economy of the modern wire-drawing shop, as well as the end use of numerous finished wire products, has dictated certain basic requirements of rods. Among these we can list the increasing demand for heavier coil weights, along with quality items such as control of section, freedom from surface defects such as rolled scale and decarburization, and uniformity of mechanical and metallurgical properties.

In designing the Johnstown mill, full consideration was given to all of these factors and every attempt was made to incorporate them into the basic design of the mill.

Rods rolled at Johnstown represent a wide variety of grades and end uses. The preponderant tonnage outlets are in wire commodities such as cold heading, electroplating, flat rolling, rope and spring wire and fine wire. These and other end uses call for the closest possible control of rod section, surface defects and other quality conditions affected by mill design and rolling practice.

Excavations, foundations and construction—Construction and installation of the Johnstown mill presented

Figure 1—Layout of new rod mill at Bethlehem Steel Co.'s Johnstown plant.

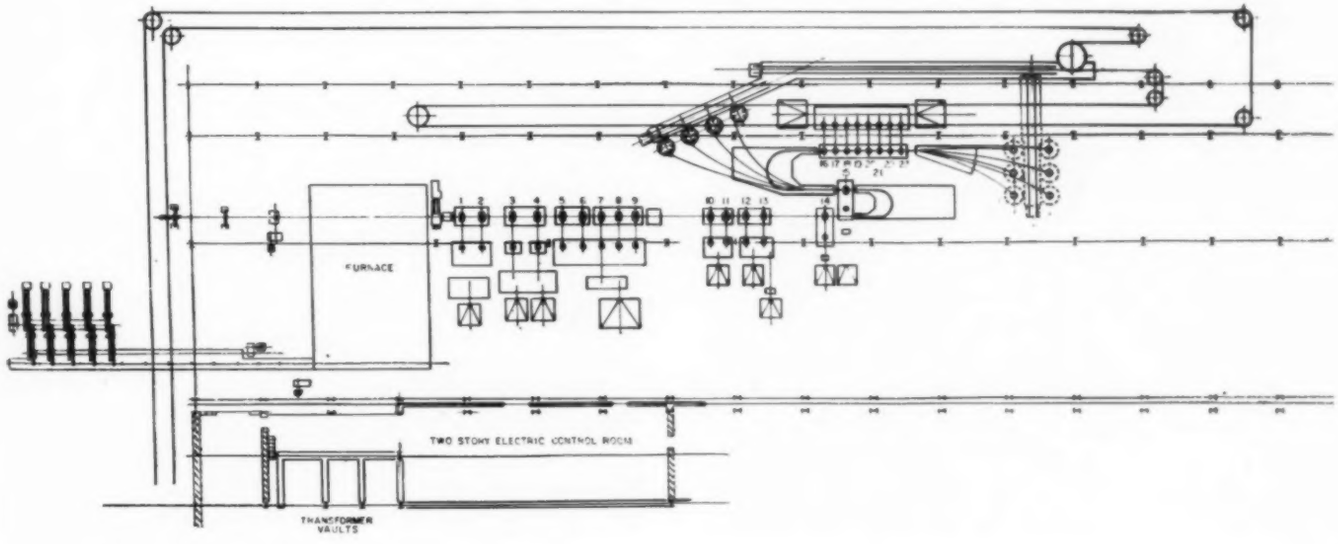


Figure 2—New finishing mill was under construction as shown on left while old mill on right was in operation.

Figure 3—View shows mill area four days after last billet was rolled on the old mill.

some unusual features. Geographical limitations required the new mill to be built on the same site and in the same buildings as the old 16-stand belt-driven mill. Since this old mill was the only local source of rods for our wire mill, it was mandatory to keep it operating as long as possible during the construction of the new mill. This situation posed some special problems and called for air-tight planning to maintain simultaneous operations alongside of excavation and construction. The actual construction period was nine months, of which 27 days were required for the shutdown. The old mill rolled rods for eight months or 89 per cent of the construction time. Construction work and installation were performed by the plant personnel except for work on electrical equipment, wiring and conduit. Rolling of the first full length billets through all 23 stands occurred on December 13, 1955. Figures 2, 3 and 4 illustrate various construction phases.

The following listing indicates the scope of the construction of the mill:

1. Excavation.....8712 cu yd
2. Concrete placed.....4965 cu yd
3. Structural steel..... 800 tons
4. Machinery installed.....1285 tons
5. Piping: water, air, steam, lubrication, and hydraulic....10,000 ft
6. Scrap removed during shutdown.....1100 tons
7. Elapsed time: Rolling steel to steel in mill.....27 days

Electrical equipment—This is the first installation involving the application of pumpless rectifiers to a rod mill.

Power is purchased at 23,000-volt, 3-phase, 60-cycle from the local utility. One 1500-kw and two 2000-kw mercury arc rectifiers, with their transformers connected directly to the 23,000-volt source, supply 595/700-volt direct current to the variable-speed shunt-wound motors driving the roughing, intermediate and finishing stands. Normally each of the three rectifiers is connected to a section of the mill (roughing, intermediate or finishing); however, in the case of a rectifier failure, the remaining two can be connected in parallel and the entire mill operated as a single unit.

Reels, fans, blowers, lubrication systems, etc., are supplied by a 1500-kva, 23,000/460-volt, 60-cycle, 3-phase transformer bank. Lighting is supplied by several 460/130 volt, single-phase transformers. Figure 5 is a

Figure 4—View shows mill area eleven days after last billet was rolled on the old mill.

Figure 5—One end of the electric control room.

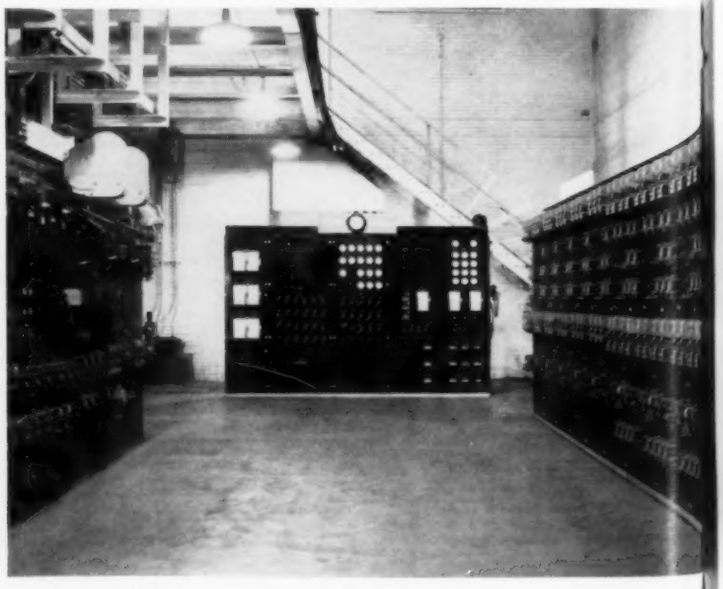


Figure 6—Two sizes of billets are stored in the yard.

Figure 7—After leaving billet yard, billets go through a billet unscrambler.

view of one end of the electrical control room. Table I shows the motors, their rated speeds and horsepower in relation to the mill stands.

Lubrication systems—There are two separate oil lubrication systems "A" and "B" which are designed to maintain automatically the required oil flow at designed operating temperatures and pressures. Continuous filtration is provided. Audible and visible alarms in the systems will indicate malfunctions or loss of lubrication.

TABLE I

Tabulation of Motors, Horsepower and Speeds in Relation to Mill Stands

Motor	Section	Mill stand	Motor horsepower	Motor rpm
A	Roughing mill	1, 2	300	250/625
B	Roughing mill	3	300	250/625
C	Roughing mill	4	300	250/625
D	Roughing mill	5, 6, 7, 8, 9	1250	225/562
E	Intermediate mill	10, 11	800	350/750
F	Intermediate mill	12	500	500/1220
G	Intermediate mill	13	500	500/1220
H	Intermediate mill	14	500	200/600
J	Intermediate mill	15	500	250/750
K*	Finishing mill	16 to 23	1250	575/980
L*	Finishing mill	16 to 23	1250	575/980

* K & L motors are mounted on opposite ends of the finishing mill gear train.

System "A" lubricates the roughing and intermediate mill, pouring reels and drag conveyor. System "B" lubricates the finishing mill and laying reels.

Hydraulic fluid systems—Two oil hydraulic systems "A" and "B" are used. System "A" supplies hydraulic pressure to the billet-separating skids and latches, billet discard, side guard on furnace charging table and disappearing stop. System "B" supplies the switch-plate traverse and lift, flying-shear traverse, roll-housing traverse, and 23 sets of top-roll counterbalance cylinders.

Billet charging—The 2½ or 3¼ in. billets, 30 ft long, weighing 630 lb and 1040 lb, respectively, are picked up from storage racks in the billet yard, weighed and then placed on the billet unscrambler bed, where they are shuffled mechanically down four steps to the charging conveyor. The billets are run three at a time by rollers against a disappearing stop, then pushed into the heating furnace through a side charging door. Figures 6, 7 and 8 are views of the billetyard, billet unscrambler and ram charger.

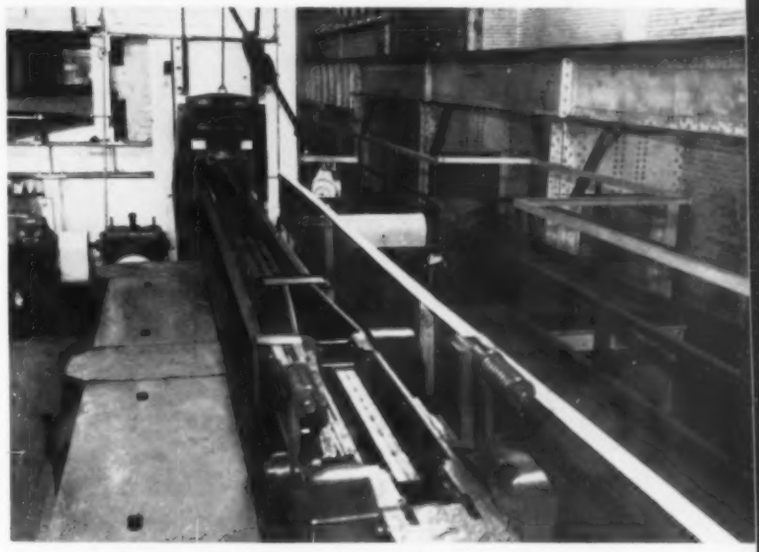


Figure 8—A ram charger pushes billets into the heating furnace.

Figure 9—Heating furnace is equipped with metallic recuperator.

Furnace—The furnace is a single-zone, side-charged, side-discharged continuous billet-heating furnace. It has an inside width of 32 ft and an effective hearth length of 41 ft, as measured from the center lines of the charging

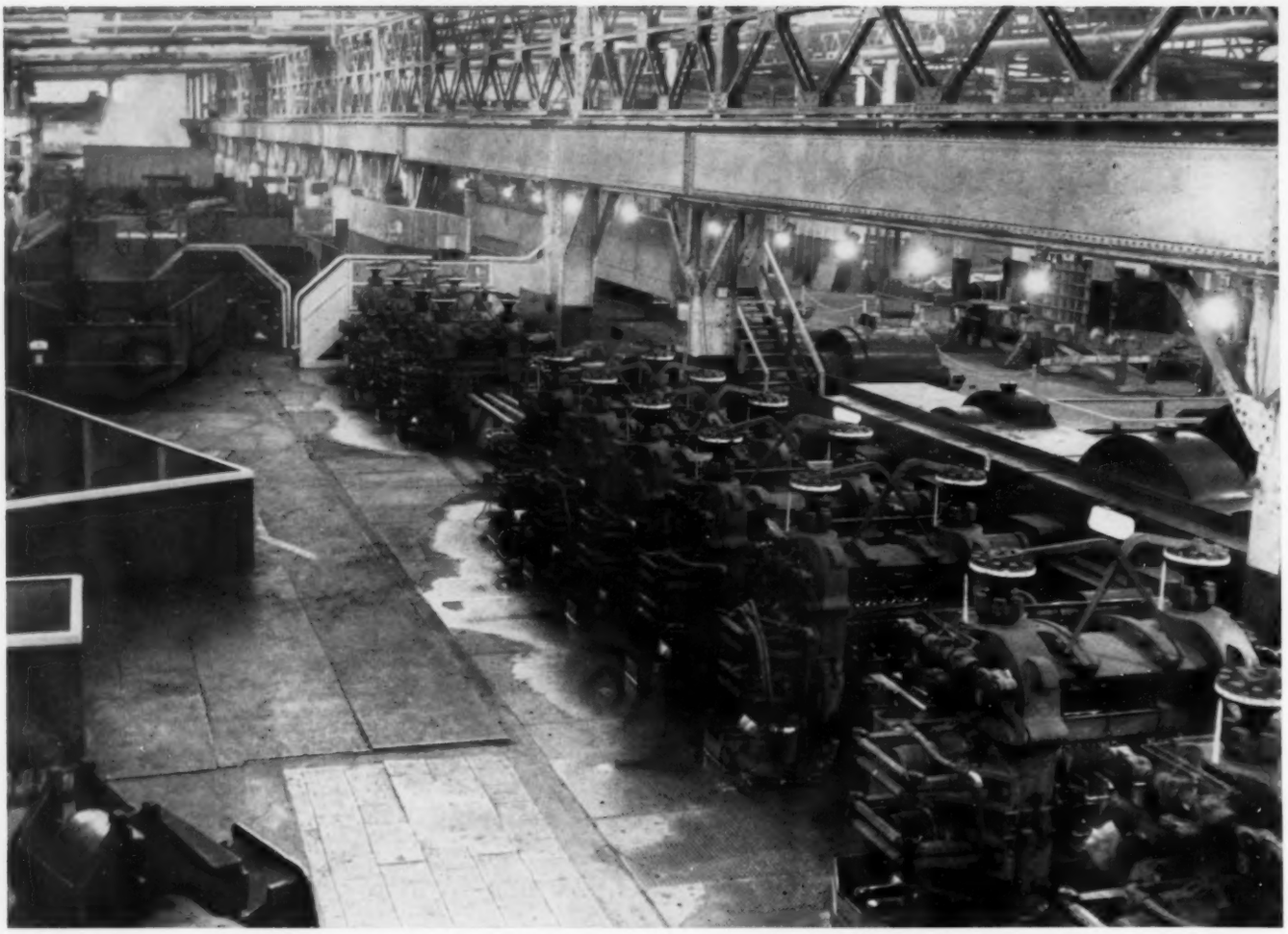


Figure 10—Housings for all mill stands are of the closed top design.

and push-out doors. The furnace holds 196, 2½ in. square billets and is rated at 90 tons per hr.

A metallic recuperator and natural-draft stack are supported on steelwork directly above the rear of the furnace. The off-take extends the full width of the furnace and flue gas rises vertically into the recuperator inlet. Preheated air from the recuperator averages about 700 F. A general view of the furnace and the recuperator is shown in Figure 9.

The fuel input to the furnace is automatically controlled from furnace temperature. Automatic control of fuel-air ratio, fuel-gas pressure and furnace pressure is provided. The furnace is equipped to burn either coke oven or natural gas. At the present time natural gas is being used.

Hot billets are pushed out from the furnace to a hydraulically operated feeder table which guides the billets into the proper pass line. A pinch roll mounted on the furnace frame is provided at this point to help push billets into the first set of rolls, if necessary, or to return a billet into the furnace.

Rolling mill and general—All 23 stands of the mill are equipped with enclosed phenolic resin bearings and roller end-thrust bearings. The top rolls in each stand are provided with hydraulic cylinders to counter-balance top-roll weight. Figure 10 is a general view of the mill floor.

The housings for all 23 stands are of the closed-top design. Precision-ground gears are used throughout the mill on all main drives, and the stands are fully equipped

Figure 11—Laying reels are fully enclosed.

Figure 12—Hooks pick up coils at the star reel.

with flat-faced roll wabblers and gear-type spindles.

Roughing train—Nine stands of rolls comprise the roughing mill. Stands 1 and 2 are paired and driven by motor A, stand 3 by motor B, stand 4 by motor C, stands 5 to 9 by motor D.

An air-operated flying shear follows stand 9 which crops the front end of the bar automatically from an impulse received from a flag switch between stands 7 and 8. The shear blade is set manually for the three pass lines.

Intermediate train—The intermediate train consists of six stands, driven singly or paired as shown below:

Stands 10 & 11—Motor E
Stand 12 —Motor F
Stand 13 —Motor G
Stand 14 —Motor H
Stand 15 —Motor J

A down-loop trough carries the bar from stand 13 to stand 14. A 180-degree repeater follows stand 15 to carry the bars into the finishing mill.

Stand 15 becomes the finishing stand for any size made in pouring reels. This necessitates lifting the second 180-degree repeater.

Snap shears are placed at the entering side of stands 15 and 16, for cutting off bars either from the floor or the control pulpit to minimize cobbles in the finishing train.

Photoelectric cells are placed at the entering side of both stand 15 and stand 16, for automatic control of the pouring and laying reels and related equipment.

Stands 15 and 16 are equipped with hydraulic shifters to adjust pass lines to repeater troughs when necessary.

Finishing train—The finishing train comprises eight stands (16 to 23), driven by twin motors K and L which are mounted on each end of the finishing mill gear train shaft.

Stands 17, 19, 21 and 23 become the finishing stands for the group of sizes made into laying reels.

Reel pipes from the finishing stands are provided with three sets of water jets and water eliminators for partial cooling. Switching of reel pipes is done by air pressure actuated by the photoelectric cells in stand 16.

Laying reels—The laying reels are fully enclosed. Each of the six laying reels is provided with a separate fan which blows 7500 cfm of air on the 600-lb coil while it is being coiled, with the draft continuing for a predetermined interval after all rings are laid.

Upon completion of the blowing cycle, the tub raises and the coil is pushed out onto the cross conveyor. The heated air from the six reels is vented to a stack outside the building. Air is turned off only while the coil is pushed out of the reel. A general view of the laying reels is given in Figure 11.

Both hand and automatic operation is provided for each pair of reels and associated equipment.

Reeling, push-off and stripping operations are interlocked. This automatically prevents malfunctioning, either with respect to proper sequence of operation, or simultaneous operations of laying reels in attempting to push coils into occupied dog spaces on the reel conveyor, where each set of reels are opposite and push into the same section of the conveyor.

Pouring reels—The four pouring reels are fully enclosed and during the pouring operation 12,500 cfm of air are blown into each reel for reducing the temperature in the reel, the heated air being vented to an outside stack.

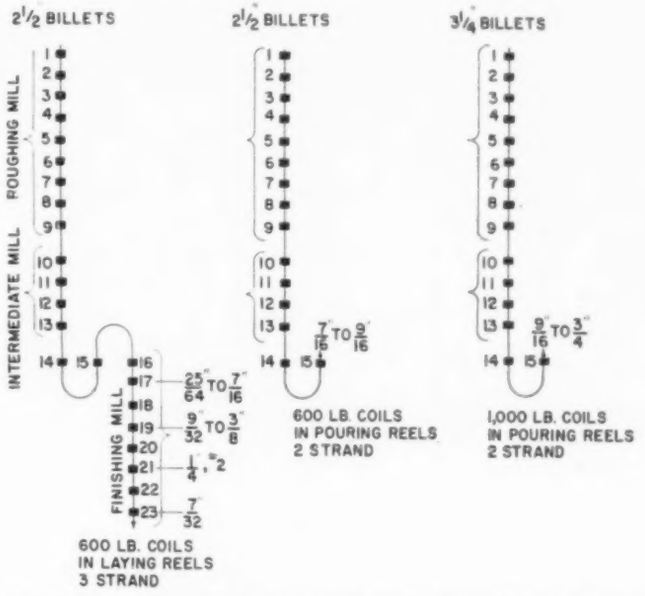


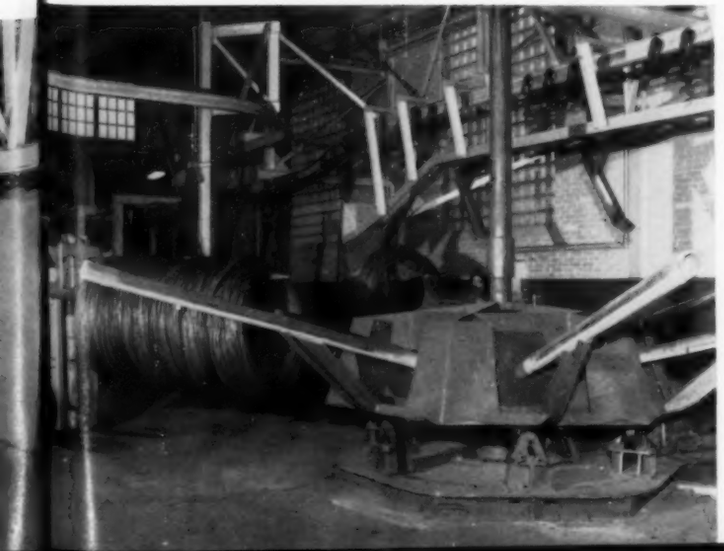
Figure 14—Diagram shows stands used for rolling various rod sizes.

Main drag conveyor—The general arrangement and relative lengths of the drag conveyor sections between the laying and pouring reels and the star wheel pick-up point on the hook conveyor were dictated by existing building arrangements and facilities. The drag conveyor lengths are very short. Air cooling facilities during coiling makes this possible.

Hook conveyor—Coil pick-up on hooks is accomplished at the star wheel, shown in Figure 12. Hooks are spaced at 6-ft centers and the coils travel through two cooling galleries overhead for a distance of approximately 1000 ft prior to trimming and inspection.

Coils are discharged from the hook conveyor on a six-pronged capstan where the coils are unloaded by ram trucks. The capstan is indexed 60 degrees after receiving 3000 lbs of coils, and unloaded after either 60 or 120 degree rotation from the receiving point. Dumping of the rod coils from the hook conveyor to the capstan bars is done automatically by cocking the hooks on a camming track which engages a set of rollers mounted on the back of each hook. Coils slide by gravity along the capstan bars which are tilted at a fixed 15-degree

Figure 13—Coils are discharged on a 6-pronged capstan.



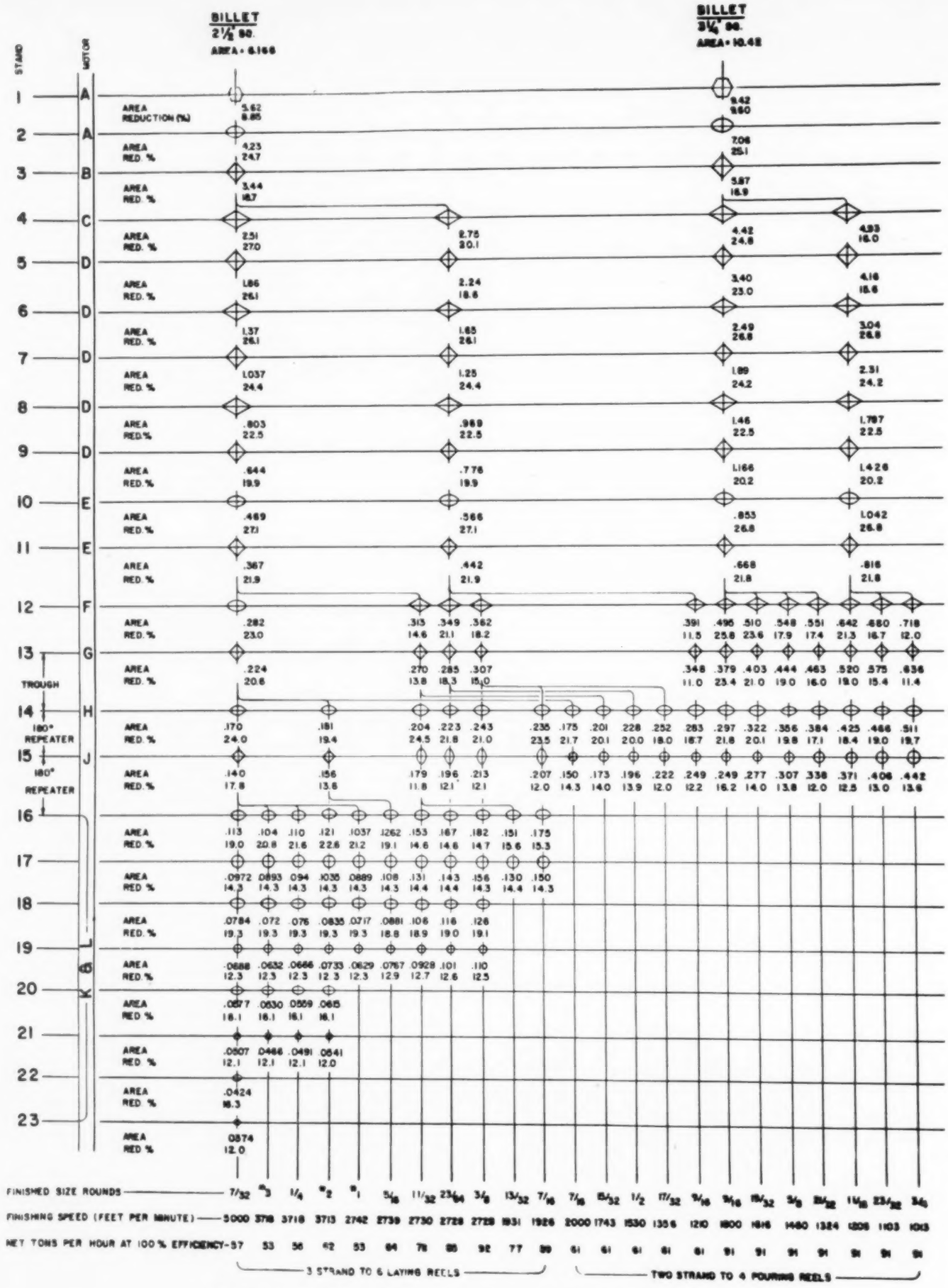


Figure 15—Procedures for rolling various sections are given by chart.

angle to the horizontal. Figure 13 is a view of this area.

Stand layouts and mill operations—Figure 14 is a diagram of the stands used for rolling various rod sizes. Figure 15 is a rolling diagram showing the various methods of rolling, type of sections and reductions. The reductions per stand in all cases are relatively light. No less than 15 stands are used for rolling the heavy range of sizes ($\frac{9}{16}$ in. and coarser diameters) which come from $3\frac{1}{4}$ x $3\frac{1}{4}$-in. billets. Stands 15 to 23 are used for rolling $\frac{17}{32}$ to $\frac{7}{32}$-in. rods from $2\frac{1}{2}$ x $2\frac{1}{2}$-in. billets. Provisions are made for three-strand rolling up to $\frac{7}{16}$ or $\frac{1}{2}$ in. in laying reels, or two-strand rolling from $\frac{7}{16}$ up to $\frac{3}{4}$ in. in pouring reels. Basically, the mill is capable of rolling all sizes at high tonnage rates. Along with high output, the mill has the desirable features of working stock down from heavier billets and maintaining relatively light reductions per stand.

Pass design presently in use consists of diamond-square sections through the roughing mill. Stand 1 rolls a side-tapered square with the top and bottom faces of the billet entering flat. Stands 2, 4, 6 and 8 are diamonds. Stands 3, 5, 7 and 9 are squares.

The oval out of stand 14 repeats 180 degrees in the first repeater into stand 15. The square out of stand 15 repeats 180 degrees into the second repeater to stand 16 which is the first stand of the finishing mill.

The finishing mill rolls oval-rounds, with ovals in stands 16, 18, 20 and 22, and rounds in stands 17, 19, 21 and 23.

Rod cooling—Air cooling in both laying and pouring reels, each of which is totally enclosed and served by their own individual blowers, in conjunction with water cooling in the run pipes, gives a very high degree of flexibility in allowing the various rod sections to be produced at optimum rolling and coiling temperatures. Thereafter, residual temperature of the bundle can be reduced to prevent secondary scaling.

Considering the relatively short time of operation of the mill, the main task up to this point has consisted in training the mill crews and going through the inevitable period of shake down runs of equipment. The complexities of the modern high-speed rod mill demand to a very exacting degree the best coordinated efforts of the mill builder, the engineer, the roll and guide designer, the maintenance and metallurgical departments and operations division.

DISCUSSION

PRESENTED BY

SHERIDAN SMITH, Superintendent Rod and Bar Mills, The Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

J. C. SEIBERT, Superintendent Rod and Wire Div., Bethlehem Steel Co., Johnstown, Pa.

F. E. FAIRMAN, III, Steel Mill Engineering, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

W. A. MILLER, Superintendent, Rolling Mills, J. A. Roebling Sons Corp., Roebling, N. J.

Sheridan Smith: There is one thing I am interested in in your mill—that is—your laying of reels in regards to the use of air and water for cooling. I was wondering if you have any information that would be of interest as Johnstown is the first mill to install equipment of this type.

What I would appreciate knowing is: have you obtained any improvement in scale loss and also have you found any difference in your acid consumption or any advantage in your drawing operations? Have you found any advantage in the air and water applications on $\frac{3}{8}$-in. round and up?

On our rod mill, we only cool our rods with water to about 1500 F and that is as far as we can go. Any lower than this, we have difficulty in laying the reel.

J. C. Seibert: We have found definite improvement in less scale loss and less acid consumption resulting from the method of air and water application to our laying reels for cooling rods. On $\frac{7}{32}$-in. rod (600-lb coils), we have conducted tests which indicate scale loss is about one half of the amount obtained formerly on $\frac{7}{32}$-in. rods (300-lb coils) using water exclusively. Acid consumption was about 25 to 30 per cent less.

On the larger rod sections, we have found definite advantages in that the surface of the drawn wire is smoother and better for extra clean bright wire and for electroplating.

The reason for the reduction in scale is the application of air first to each individual ring of rods while the coil is laid, and secondly to the additional blowing of the coil in the closed tub for about 30 sec after all rings are laid. Air application is made beyond the laying reel spinner head, which of course eliminates the difficulties arising from spinning at too low a temperature. For example in the case of $\frac{7}{32}$-in. rods, the temperature of the bar leaving the last roll stand is approximately 1850 F. Water applied in the run pipes between the finishing stand and the reels reduces the temperature to 1550 F which would be the approximate temperature of the rod in the spinner head. Air cooling then quickly reduces the coil temperature to 1350 F or colder if desired.

F. E. Fairman, III: A new type of electric drive system was applied on this rod mill. In addition to the use of a pumpless mercury-arc rectifier power supply, the new system uses mill type motors having standard impact speed drop characteristics with speed regulators for each main drive. Extensive use of the electronic computer was made in the design of this new rod mill control system. The mill was "run" on the computer to check the selection of equipment and to eliminate problems before installation. As a result of these computer test runs all resistor and capacitor settings were close to their final values before the electric equipment was installed and the proper adjustments were more easily determined at the time of start-up. It is significant that not a single circuit in the regulating system was changed during start-up, although this was the first installation of a rod mill with this type of speed regulator.

W. A. Miller: Do you use roller guides throughout your mill or do you just use friction guides?

J. C. Seibert: The only time we use roller guides is when the number 15 stand becomes the finishing stand. We are using nothing but friction guides.

Electrical Equipment for Continuous Annealing

By
G. J. HAY
Steel Mill Engineer
Westinghouse Electric Corp.
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and
H. S. FEGELY
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Buffalo, N. Y.

▲ SILICON steel is utilized extensively in the manufacture of electrical equipment because of its desirable magnetic properties. In order to improve the magnetic properties and the initially hard and brittle physical properties, the strip is subjected to a continuous annealing process.

The electrical drive systems, which move the strip through the line, include precise speed, voltage and tension control. In the entry section, regulated tension is maintained as the strip is subjected to electrolytic cleaning in preparation for subsequent processing.

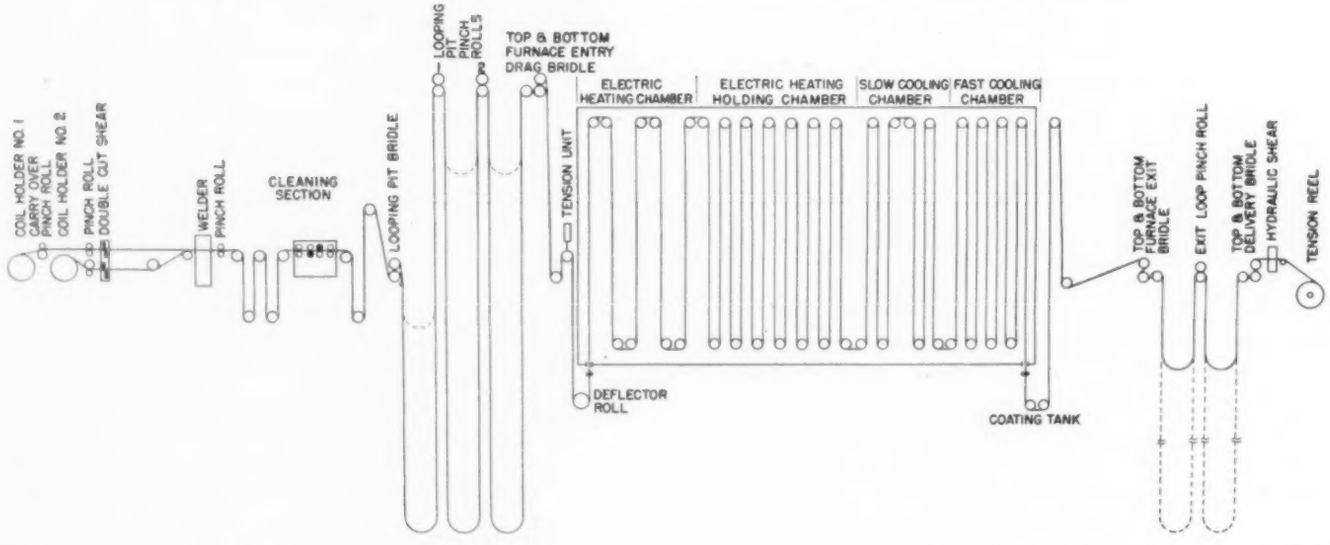
In the processing section, the metallurgical characteristics of the strip are determined. One of the quantities which aid in this determination is speed which receives particular attention from the standpoint of regulator design. Tension is also important in that when the strip is heated to furnace temperature, excessive tension may cause a reduction in strip cross section with resulting high scrap losses during subsequent processing.

In the delivery section, the strip is rewound under regulated tension.

Recently installed facilities for the continuous annealing of silicon steel strip in a Pittsburgh area steel plant are designed to handle strip widths of 18 to 42 in. and strip thicknesses of 0.007 to 0.031 in. Each line has a nominal production capacity on 0.014-in. thick by 30 in. wide strip of 20 tons per hour at 460 fpm on a stress relief cycle and 8 tons per hour at 184 fpm on an anneal cycle. Minimum continuous line speed is 50 fpm with 25 per cent overspeed available in the entry and delivery sections to restore loops to normal following coil additions or removals.

The pass line diagram outlining the major drives is shown in Figure 1. In the entry section, these drives consist of the magnetic amplifier current regulated coil

Figure 1—Mechanical pass line diagram of continuous silicon steel annealng line.



.... an all-magnetic amplifier regulating system (with the exception of loop control) is in successful operation on a major processing line .... the design enables factory assembly and adjustment in the factory prior to startup .... increased reliability and reduced maintenance are possible ....

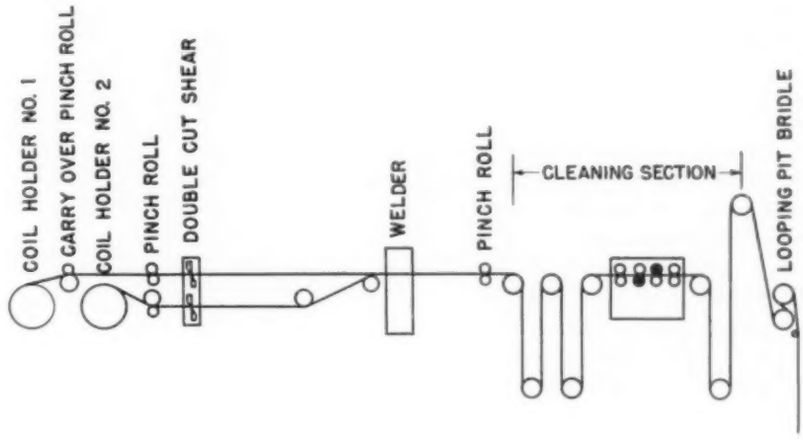
# of Silicon Steel Strip

holder drag generators and the double drive looping pit bridle. Also included is an electrolytic cleaning section consisting of five adjustable voltage sink roll and scrubber backup roll helper drives.

Three free-hanging loops, separated by the looping pit pinch roll drives, provide a strip reservoir during coil additions and move the strip to the processing section. The major drives in this section include the furnace entry drag bridle with position control and the furnace exit bridle. Also included are the adjustable voltage furnace helper drives. Two looping pits, approximately 70 ft deep, provide a strip storage area during coil removals and are separated by the exit loop pinch roll drive which also helps to move the strip to the delivery section. In this section, the major drives include the delivery bridle and the magnetic amplifier current regulated tension reel.

Reference is made to Figure 2 for a magnified view of the entry section pass line with simplified schematic added. The generator is controlled by a magnetic ampli-

Figure 2—Entry section mechanical pass line and simplified schematic diagrams for 42-in. continuous silicon steel annealing line.



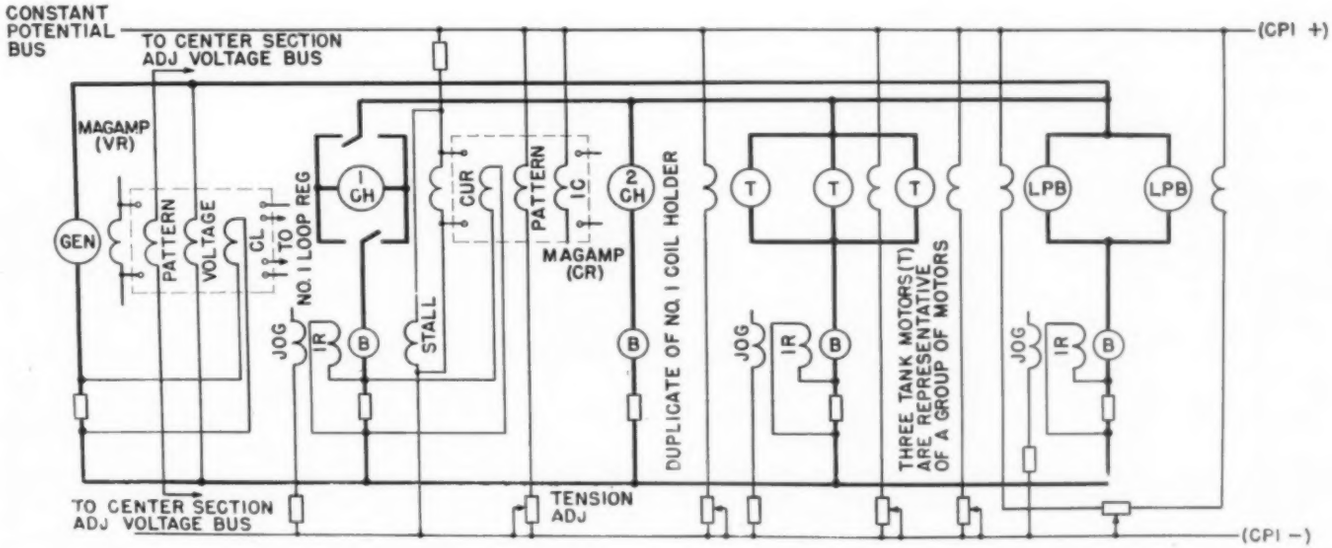


Figure 3—Partial view shows d-c adjustable voltage control panel for entry section with flow of material from right to left.

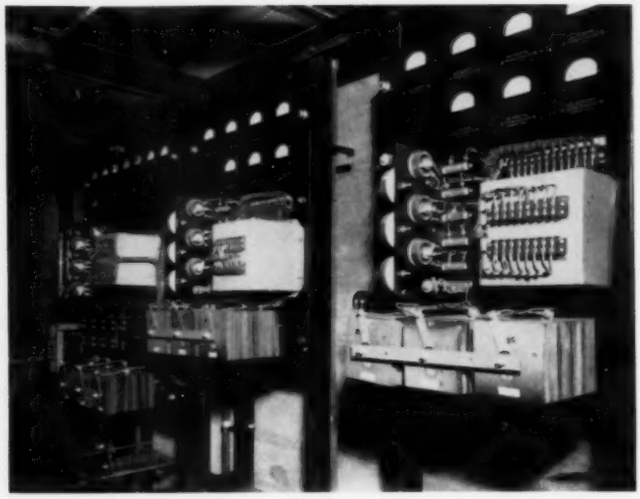


Figure 4—Magnetic amplifier regulator panels are mounted in d-c, adjustable voltage control panel resistor rack.

fier voltage regulator (VR) with modifying current limit and loop level signals. During normal operation, this arrangement maintains the flow of material into the storage pits at the same rate at which it is withdrawn.

The loop level modifying signal is provided by an integrating type photo-electric regulator so that the generator voltage is adjusted to maintain loop 1 at its normal operating level.

It is assumed that constant speed is maintained in the processing section; therefore, the downtime required for coil additions is a determining factor in the design of the storage loops. Since acceleration and deceleration times are a part of the total downtime, they must be as short as possible commensurate with the commutating ability of the drives. A separate regulator control field, provides the current limit signal which modifies the rate of change of generator voltage to keep either the positive or negative loading within the momentary rating of the machine.

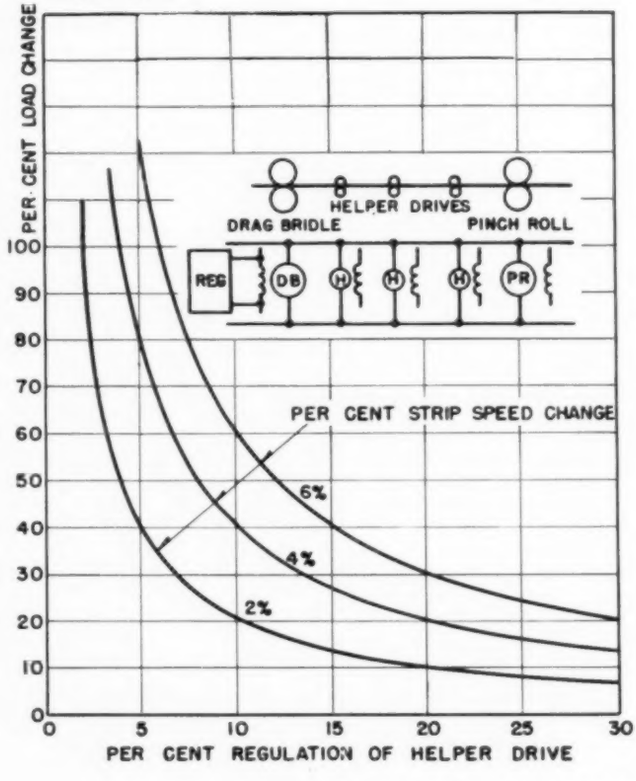
In order to obtain regulated strip tension, the coil holder shunt field is excited by a magnetic amplifier current regulator (CR) which obtains a current feedback signal from a dropping resistor in the armature circuit. It is required that the strip tension be held constant over the coil diameter range. Since the strip tension is proportional to shunt field current, armature circuit current and coil radius, the shunt field current must be adjusted for a decreasing coil diameter in order to hold armature circuit current constant and hence, strip tension essentially constant. Modifying factors such as gearing efficiency may vary actual strip tension within acceptable limits.

During the coil addition operation, the current regulator output must be modified to hold strip tension while a rapid change is made in the stored energy of the coil holder drive. This signal modification is called inertia compensation (IC) and is applied when the rate of change of generator voltage, as determined by simple electronic component, exceeds a given value.

The direction of rotation of the coil holder No. 1 for over- and under-payoff operation is selected manually by a knife switch mounted on the adjustable voltage panel. A section of this panel is shown in Figure 3 with the flow of material from the right to left. For convenience during maintenance, telephone jacks were provided at approximately 12-ft intervals. The necessary metering, associated with the individual drives, is flush mounted on steel panel sections. Note the extensive use of wiring troughs. This practice prevailed throughout the entire installation.

Mounted in the resistor racks behind the panels are the magnetic amplifier regulators as shown in Figure 4. Each regulator unit is mounted on a steel panel and completely wired as part of the control assembly. This arrangement results in a saving in space and installation costs for the customer. Indicating meters are mounted on a hinged steel panel located adjacent to and above the regulator panel for convenience during start-up adjustment.

Figure 5—Increased regulation reduces load change of helper drives.



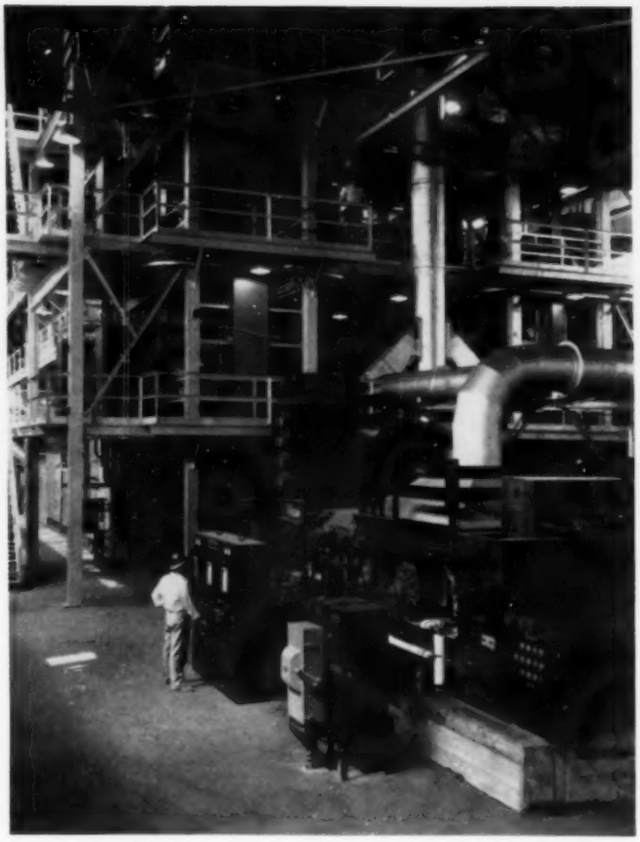


Figure 6—Entry end of continuous annealing line shows strip moving through looping towers.

The tank roll drives are designed with 18.2 per cent regulation at gear-in speed in order to minimize the effect of load changes which occur when the strip speed varies slightly due to the inherent regulation of the looping pit bridle. These small speed changes result from a change in the coil holder tension setting or when friction loads change.

An example and curves showing the effect of droop in minimizing load changes is shown in Figure 5. The example shows a section of a processing line with a drag bridle which sets strip tension, several helper roll drives and a pinch roll drive which sets line speed. If the operator adjusts tension on the drag bridle, there will be a corresponding load change on the pinch roll. This load change will cause a speed change on the pinch roll which changes the strip speed through the section. Since the helper rolls are in contact with the strip, there will be a corresponding speed change on these drives and also a load change. The curves show the effect on helper drive with line speed changes of 2, 4 and 6 per cent for different values of helper drive regulation. It is apparent from this curve that even a relatively small change in line speed of 2 per cent can cause a 30 per cent shift in helper drive load if a stabilized motor having 7 per cent speed regulation is used for the helper drive. Increased droop to about 15 or 20 per cent on helper drives results in relatively small load changes even for strip speed changes as great as from 4 to 6 per cent. Insufficient droop on these motors results in a line that is difficult to set up and control.

Droops on helper drives can be obtained by armature resistance, by inherent machine regulation from a series field or by a combination of these methods. In many cases, fast deceleration is required, and where load inertias are high, attention must be paid to regenerative loads on the motors during deceleration. Since series fields are in the wrong direction for regenerative currents, large decelerating loads can cause considerable loss of motor braking torque.

Figure 7—Perspective view shows entry end, looping pit 2. Note strip guide magnets.

There are several ways to prevent this condition—one is to use standard stabilized motors with sufficient external armature circuit resistance to give the droop required. This approach will work well on acceleration and deceleration, but because of the relatively high IR drops in the machine and its external resistor, the helper drives will tend to drop load as line speed is reduced. For applications where the tendency to drop load must be kept to a minimum, it is preferable to obtain the necessary droop by series field, thereby keeping the IR drop to a minimum. If these applications have a decelerating problem, shunt field forcing during the slowdown may be required to counteract the differential ampere-turns of the series field and prevent loss of torque. If IR compensation is added to help the drives with series fields, load setting will stay constant over wide operating speed ranges.

An interesting view from the entry end of the line is presented in Figure 6. Note the two pass lines visible in the looper towers on each side of the cleaning section exhaust stack. The closest pass is leaving looping pit 1 and entering the second entry end pit. Attention is called to the 1000-kva, 6600-volt furnace heating power centers located on the second and third platforms of the looper tower. A total of six power centers were furnished for each line and are arranged in three or four feeder circuits depending on the furnace zone requirements.

An interesting perspective of looping pit 2 taken from the second looper tower platform level, is shown in Figure 7. Permanent and electro-magnets are utilized to stabilize the free-hanging loops. The actual pits are 50 ft deep below mill floor level as located by the man viewing the movement of a weld through the looping pits.

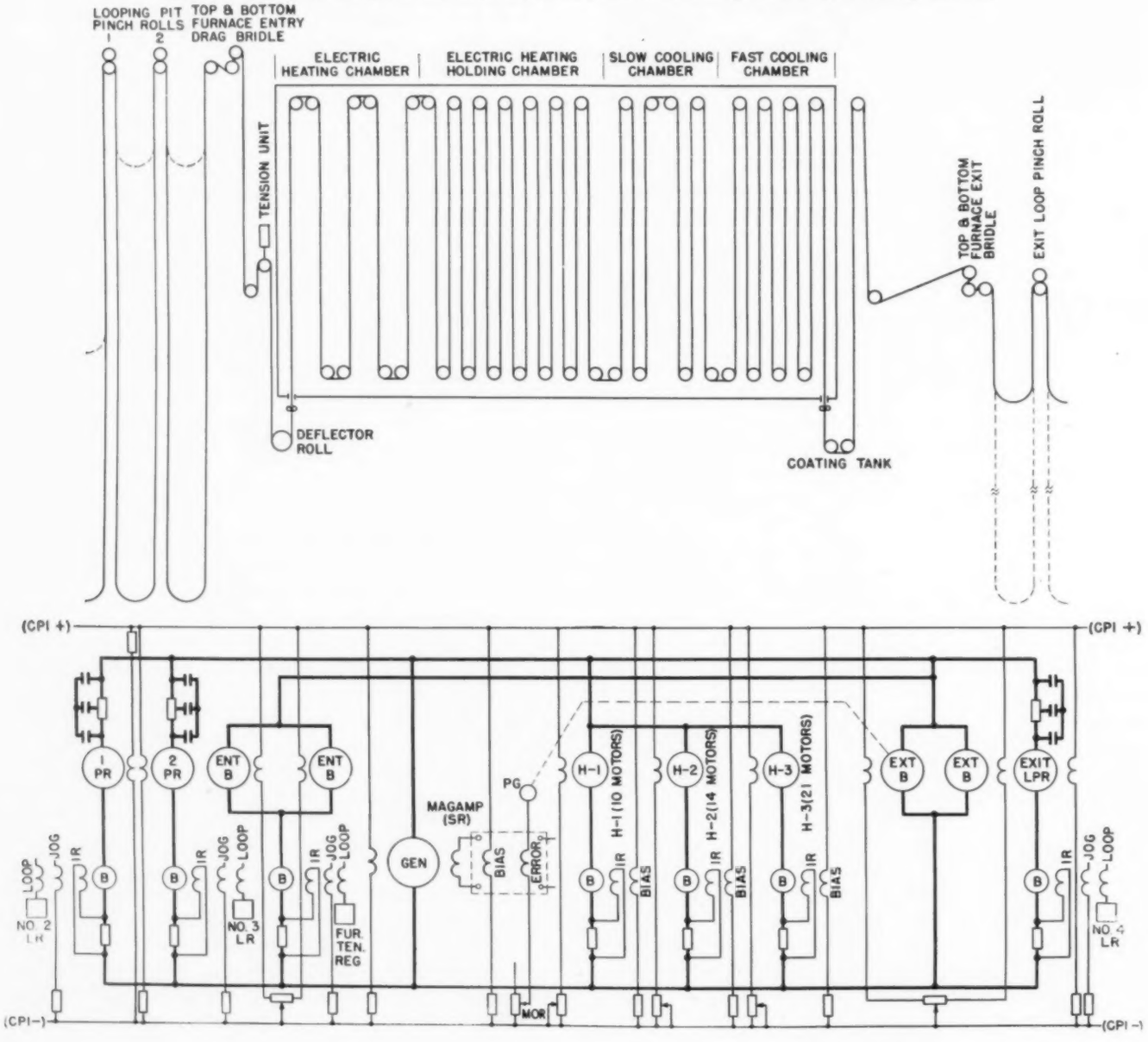
Moving on to Figure 8, a closer look at the processing section pass line and simplified schematic is presented. The looping pit pinch rolls are connected to the adjustable voltage bus. Loop 2 and 3 control is provided by integrating type photo-electric regulators operating on the looping pit pinch roll booster generators. Control for

the looping pit pinch rolls is arranged for individual raising or lowering of each loop. Briefly, the scheme of operation during an entry section coil addition is to stop the looping pit bridle by entry section regenerative braking. After depletion of loop 1, looping pit pinch roll 1 is stopped by dynamic braking. The same control sequence is followed after loop 2 depletion. Approaching full depletion of loop 3 causes a line emergency stop by regenerative braking. After the entry section weld is completed, the loops are refilled in the reverse order of their emptying. The looping pit pinch rolls are returned to the adjustable voltage bus by three point magnetic acceleration. Overspeed to fill loops is obtained by overvoltage supplied by the respective pinch roll booster generator on a signal from the loop regulating system.

Several advantages result from this scheme of individual loop control. Strip storage facilities are utilized to the maximum in that full capacity of each loop is available. The scheme is economically attractive in that the control is simplified and odd voltage booster or individual generators are not required. Preliminary brush tests indicated that the unbalanced load conditions caused by the different weight of strip in each loop during a coil change are not objectionable electrically. No mechanical problems have developed from a maintenance or operation standpoint.

The primary requirement of the processing section entry and exit bridle drives is to move the strip at a constant speed under controlled tension. In order to maintain a constant speed, the section generator output is controlled by a magnetic amplifier speed regulator (SR). The speed error field of the regulator sees the difference voltage between the reference signal established by the motor operated rheostat (MOR) and the speed feedback signal established by the pilot generator driven by the furnace exit bridle. The net control signal, adjusted by the bias winding, results in a regulator output which adjusts the generator voltage to an exact value corresponding to the desired speed of the bridle. This high gain regulator system is designed to maintain a strip speed accuracy of plus or minus 2

Figure 8—Mechanical pass line and simplified schematic diagrams of processing section.



per cent at 100 fpm with proportionately better per cent accuracy at maximum strip speed. Since stability becomes an increasingly important consideration in the design of a high gain system, appropriate damping must be included in the feedback circuits.

Controlled tension is an equally important consideration, one reason being that excessive amounts will cause "necking" of the strip, particularly at elevated furnace temperatures, with resultant material losses during subsequent side trimming operations. On some applications, where high tension is maintained and limited variation is permissible, current regulation is satisfactory. However, where high accuracy is desired and must be maintained over a wide line speed range, constant current does not result in constant tension

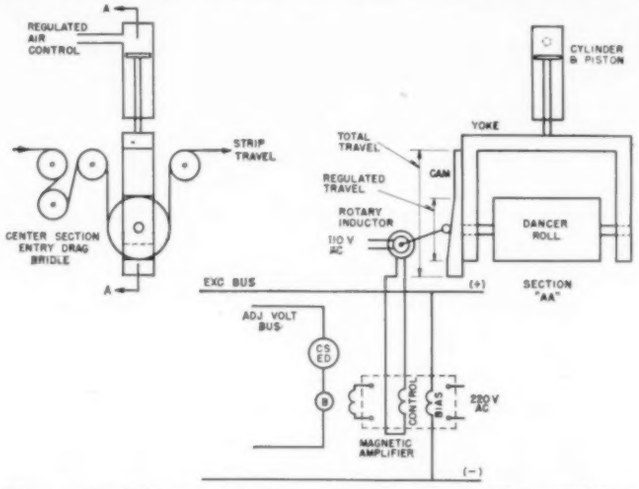


Figure 9—Rotary inductor-magnetic amplifier position control scheme.

since the regulator cannot differentiate between current resulting from strip tension, and that contributed by the electrical and mechanical losses of the system.

In this installation, the tension is controlled by means of regulated air pressure operating in conjunction with an integrating type photo-electric position regulator. The air pressure is applied to a piston, which through a yoke, supports a dance roll. A system of counterweights neutralizes the downward force due to the weight of the roll so that the upward force acting against the piston is equal to the downward force exerted by the strip tension. A change in strip tension resulting, for example, from a variation in friction load causes the dancer roll to seek a new position. The position regulator, through the furnace entry drag bridle booster generator, increases or decreases the speed of the drive as required to return the dancer roll to the zero regulating position.

If operating difficulties necessitating a normal line stop are encountered, the line comes down in speed under regulated tension. Because this tension may require considerably more current than is desirable to maintain through the armature circuits at standstill, a timing relay monitors the motor operated rheostat zero position and the tension regulating circuits drop out through the following timed sequence. At the end of an initial 10-sec time delay, the entry drag bridle brakes set. After an additional 2-sec time delay, the loop regulating circuits drop out. This control system prevents loss of tension which might otherwise occur if the loop regulating circuit was released at the same instant that the brakes were set.

Figure 10—Side view shows furnace looking toward entry end with coating unit drying passes in left foreground.

In order to resume operation, tension must be manually selected by the operator. If the section is not brought up to speed within the 10-sec period, the timed sequence, previously described, will be repeated.

A second method of regulating dancer roll position has recently been developed and incorporated in the tension regulating system as shown in Figure 9. With a given regulated air pressure, a change in strip tension causes the dancer roll to seek a new position. This action in turn, through the cam and spring-loaded rider wheel, results in an angular displacement between the rotor and stator of the rotary inductor. Thus with 110 volts applied to the rotor, the output voltage of the stator winding will vary from zero to full voltage for 90 degrees of rotation. Since the output voltage varies as the sine of the angle of rotation, the regulated travel distance of approximately 30-in. is designed to correspond to approximately 60 degrees of rotor rotation in order to obtain approximately linear output voltage.

This output is rectified and the d-c signal is applied to the control winding of the magnetic amplifier. Since the magnetic amplifier is a uni-directional device, the bias winding is connected across the excitation bus in order to provide essentially zero output of the magnetic amplifier when the dancer roll is at the zero regulated position. The booster generator (B) voltage, as determined by the output of the magnetic amplifier, will be maximum negative for a dancer roll position below normal regulated travel and maximum positive for a dancer roll position above normal regulated travel in order to adjust entry drag bridle speed to maintain dancer roll zero regulated position.

A view of the furnace installation looking toward the entry end of the line is shown in Figure 10. As an operational aid, patented, fail safe, strip guide and strip break alarm systems are installed in the furnace. The guide alarm system warns of faulty tracking which can result in excessive wear and possible shut-down. The break alarm system detects the strip break and indicates the zone in which it occurred.

Each of the furnace rolls is driven by an individual gearmotor operating as a helper drive to overcome the friction drag of the rolls and prevent strip tension build-up in the furnace. The paralleling of these unregulated drives on a common adjustable voltage bus dic-

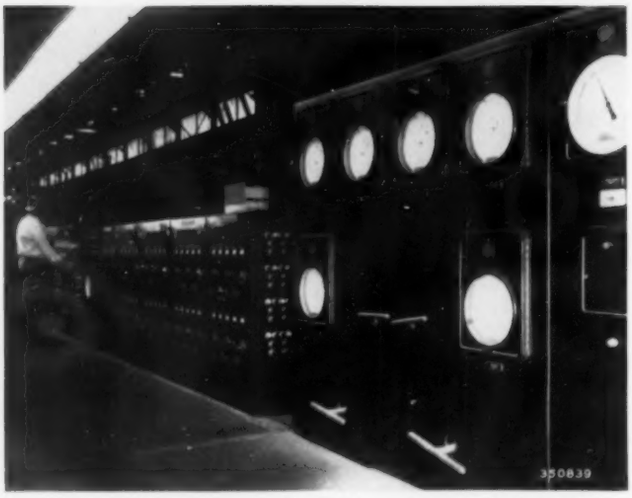


Figure 11—Main operator's station. Partial view of furnace atmosphere control is also given on the right.

tated a design which resulted in a 16.8 per cent regulation at gear-in speed and rated voltage.

The main delivery operator's station with a part of the furnace atmosphere control on the right is shown in Figure 11 as an example of the fourteen stations conveniently located along the length of the line as operator control points. All stations are either wall or floor, 54 and 76 in. high, mounted cabinets and are designed to conform to mill practice. Each station is laid out for maximum operator efficiency.

Reference is made to Figure 12 for a magnified view of the delivery section pass line and simplified schematic diagram. As was the case with the looping pit and processing section bridle drives, two rolls of the delivery bridle are individually driven which necessitates a

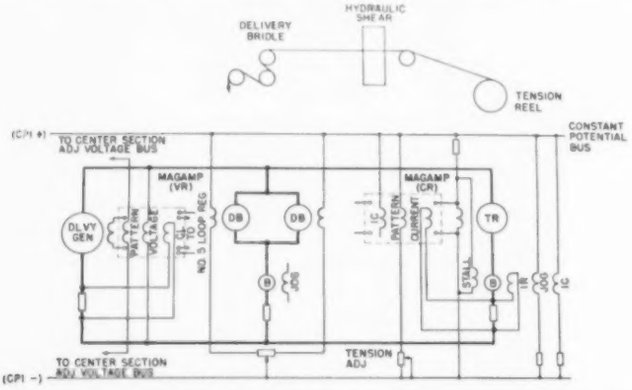


Figure 12—Mechanical pass line and simplified schematic diagrams of delivery section.

system of load balance consisting of wire wound series fields with associated dropping resistors and rectifiers. The shunt field currents are adjusted by means of a common load balance rheostat.

Following the coil removal, the trailing edge of the strip, after shearing, is secured on the strip reel mandrel and section stalled tension is established. In order to accomplish this, the delivery bridle brakes are set and the magnetic amplifier current regulator (CR) excites the strip reel booster to cause a regulated current to circulate in the delivery bridle-strip reel armature circuit loop.

During section restart, smooth transition to run tension from a stall tension condition is obtained by the control design arranged to maintain the regulated strip reel booster voltage during run conditions. This arrangement is desirable because the low booster voltage required to circulate stalled tension current has a negligible effect on the running strip tension, the stall field excitation assists in maintaining armature current during breakaway and acceleration to minimum line speed, and only a change in pattern field excitation is required for transition between run and stall tensions. Thus the control scheme provides the features of running tension adjustable from 10 to 100 per cent of machine full load rating, a regulated stall tension and a very smooth transition between the two tension conditions.

With the exception of the loop control, all magnetic amplifier regulator systems are employed which represent an industry first for a major processing line. This design works to the customer's advantage during start-up in that the regulator can be factory assembled and adjusted within the accuracy limits of the calculated shunt field, friction load and drive inertia data. Also the static regulator plus features of increased reliability and reduced maintenance are realized. These new facilities, with control design features such as have been described, produced the first coil as salable product and will continue to provide a source of electrical steel having the high metallurgical qualities required by the electrical industry.

DISCUSSION

PRESENTED BY

J. J. REMLEY, Steel Mills Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

J. C. DAVIS, Engineering Dept., Irvin Works, United States Steel Corp., Dravosburg, Pa.

R. P. FORRESTAL, Engineering Supervisor, Engineering Dept., Cutler-Hammer, Inc., Milwaukee, Wis.

H. S. FEGELY, Control Design Engineer, Westinghouse Electric Corp., Buffalo, N. Y.

J. J. Remley: We like the elimination of the motor operated rheostat on the entry and delivery sections of the line which must accelerate and decelerate every coil. This was accomplished by the use of current limit to achieve a constant rate of change of voltage. However, this results in a high rate of rise of current at the start of acceleration. Circuits are available today which give a constant rate of change of generator voltage without the use of current limit.

Practically all lines to date have used simultaneous emptying and filling of multiple loops. It is interesting to note that this line empties the loops one at a time, rather than simultaneously. Putting the loop pinch rolls on the furnace generator, however, must have been dictated by economy, because the use of speed regulators and individual generators will give a much smoother operation. This eliminates the problem of when to initiate magnetic acceleration of the loop-controlled feed rolls and boosters to get the pinch rolls back up to speed.

From the simplified circuit diagram it appears that the inertia compensation is applied as a block. If this is true, how is the signal initiated and taken off at the proper time, since there are no motor-operated rheostats or other apparent devices to tell you when the acceleration cycle is complete?

Also, there are three different rates of acceleration to be considered. One is when the section accelerates to the over-speed condition. The second is the decelerating rate from the over-speed condition back to normal line speed under the control of the loop control in the pits. The third is the stopping from line speed. The author states this is the first major processing line to be put into service with all magnetic amplifier regulators, and I believe he is sincere in that opinion. However, to keep the record straight I feel obliged to point out that our company furnished all magnetic amplifier regulators for the continuous heavy gage galvanizing line at the Gary Sheet & Tin Mill of the United States Steel Corp. This galvanizing line had approximately 40 adjustable voltage motors on it. This line was put into service late in 1954.

J. C. Davis: These facilities are up to date with respect to recent advances in the electrical art, particularly with regard to the use of magnetic amplifiers, and a comparatively short period of operation has indicated satisfactory performance and application of these regulator systems.

It will be of interest to electrical engineers involved in installation of this type equipment to know that cable tray was used almost exclusively for the support of both the control and power cables, including the 6600-volt primary feeders. In many cases, the cables were concentrated in one particular place and the flexibility of this type cable supporting system permitted routing the cables through these congested areas where conduits could not be conveniently used.

R. P. Forrestal: The authors have shown in a concise manner a method of applying electric drives and control equipment for a continuous annealing line. As in any problem, several solutions are possible, the authors selected current limit as a means of accelerating and decelerating the entry and delivery sections. For the entry section we would select time limit, on the basis that there are quite a few motors to be held together and inertia compensation problems would be easier.

The simple method of loop control described must be considerably less expensive than the speed-regulating type usually used. I would like to solicit the authors' opinion as to whether this method would be suitable when heavier material is used or when the annealing speed is faster.

In the paper the authors briefly described a load division method for the tension bridles. I wonder if they could elaborate a little on that.

H. S. Fegely: Mr. Remley spoke of the rate of change for the generator voltage control, which perhaps they would choose in place of the current limit. Like all control designs, there are a good many ways to do the same job successfully. I agree that a voltage rate circuit would be one of the good ways to do it, in place of current limit. In this particular case I believe that current limit rate of acceleration is doing an adequate job. Like so many other things in which progress takes place quite rapidly, particularly in the last two or three or four years, the electrical art has progressed extremely fast, so many new instruments and pieces of equipment may be used and are available to us now that even two years ago were not available.

We might point out that this control was designed approximately two years ago. In the meantime we are aware of circuits for voltage rate of change control and, in designing another similar control, would consider both voltage rate and current limit control.

Mr. Remley has indicated that his company perhaps would use individual generators on the three-loop controls on the entry end and the two on delivery end. There is no question that such a system works well. On the other hand, the economy of the equipment to be supplied must be considered, first, as to the immediate expenditure and, secondly, maintenance expenditures that may occur, as well as the ease of installation and many other factors. We felt that the use of the generator with the boosters, which we have used as the means of controlling the loops individually, lends itself quite well to this particular installation.

A simple device which is sensitive to rate of voltage change, monitors the generator voltage. When a change occurs which exceeds a predetermined rate, a relay closes and applies inertia compensation. The voltage rate detector, in effect, replaces the control circuit which would have been available if a motor operated rheostat had been used.

The use of the rate detector also causes inertia compensation to be applied when the loop refill cycle is in operation. This type of circuit, then, is particularly convenient under such circumstances.

Mr. Forrestal has questioned whether or not the loop control, with the method in which we have handled the loops individually, might be adaptable to faster annealing lines and heavier strips. I see no reason why this should not apply to almost any type of line where you must provide for storage facilities. Personally, it seems like an excellent way of handling storage facilities, and the control is extremely simple. I have designed other lines in which we have tried to hold multiple loops together, pulling them out in multiple under control, and it gets to be a considerable problem. When we design such a line we always look for a better way to do something, an easier way, a cheaper way, and this certainly falls into that category of having the loops pulled out one at a time and refilled one at a time.

Load balance must be considered when two motors are mechanically connected together through the strip, such as you have in the bridle with two motor drives. You cannot have one not sharing the load with the other. The easy way to do that is to provide series fields on the motors so as to obtain drooping characteristics. Adjustment of the motor shunt field by manually controlled rheostats will establish the proper initial conditions for load balance.

In this particular control, we use a wire wound series field, excited from an IR dropping resistor. The series field circuit includes a bridge rectifier and resistors so the slope of the drooping characteristics can be adjusted. The two motors can then be provided with similar characteristics to give good load balance.

. . . . accurate weighing in the steel plant is necessary to insure that the customer gets the full amount of steel . . . . the steel company is also protected from loss . . . . scales, however, are only as good as the weigher . . . .

Maintenance of weighing scales

By G. E. EVANS, Scale Repair Foreman,
Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

▲ ONE of the commonplace and sometimes overlooked mechanisms involved in the manufacture of steel are the scales. The scales however play a very important part in the steelmaking process. Accurate measurements of quantity must be recorded at every step of the long and complex route required to transform a number of raw materials into a single steel article. Scales afford the one and only practical means of furnishing an exact accounting day by day and department by department of where the plant stands in terms of materials used and steel produced. For these reasons, scales are an important part of the efficient operation of any steel plant. They also insure that the customer gets exactly what he has ordered in terms of weight.

At the Sparrows Point plant of Bethlehem Steel Co. the actual weighing of materials is done mainly by the operating personnel; however, some scales are operated by the accounting department. While the responsibility of weighing may be somewhat decentralized, the efforts of the weighers in all departments are supplemented by the chief weigher and the shipment checkers who are members of the accounting department. The maintenance of the scales and the constant checking of them for accuracy are the responsibility of the scale repair department which is one of the subdivisions of the general mechanical department.

There are a total of 460 scales in the Sparrows Point plant, which are basically alike only in that they all do a job of weighing, but they differ radically in design and construction due to the variety of uses to which they are put. Before describing the organization of the scale repair department and some of the maintenance techniques used, it might be well to first classify these scales as to their purpose and then further classify them with respect to the types of indicating mechanisms used.

Bench scales—Figures 1 and 2 show these small instruments which stand on a work bench or table. Their use is limited to relatively light weighing.

Figure 1—This scale is limited to light weighing.

Figure 2—Bench scales can be of the built-in type.

Figure 3—Platform scales are easily made portable.

Portable platform scales—Figure 3 shows a platform scale with four main bearing points. These are usually provided with counterpoise weights and a weigh beam and having a weighing capacity ranging from 500 to 2500 lb. These may or may not be fitted with wheels.

Heavy duty industrial scales—See Figures 4 and 5. These are large mechanisms capable of weighing very heavy objects—sometimes called "built-in-scales" because they are designed to require a heavy permanent foundation in the location where they are used.

Motor truck scales—Figure 6 shows these heavy-duty scales especially designed and located for the purpose of weighing power-driven vehicles and trailers.

Railroad track scales—Figure 7 shows scales especially designed for weighing railroad equipment.

Belt or conveyor scales—These are devices that weigh the material carried by a conveyor system, such as a conveyor belt, and automatically totals the weight of material moved in terms of pounds or tons per hour, etc. Figure 8 is an electronic load cell type with counter as shown in Figure 16. Figure 9 is a mechanical weighing type.

Hopper scales—Figure 10 shows a scale provided with a hopper or box for weighing ore, coal, or any non-fluid material as it flows from the hopper.

Larry car scales—A scale, usually a hopper type, mounted on or in the structural frame of a railroad car; the entire assembly being movable along a track are called larry car scales. See Figure 11.

A number of different indicating mechanisms are used on the scales; the main types of which are:

Weighbeam—Figure 12 shows the element in a scale upon which by manipulating the poise and counterpoise weights, either or both, the load on the receiving element is balanced and the amount determined. Some are equipped with a type-registering poise (operated by squeezing a grip) which stamps the weight on a card.

Dial—Figure 13 shows how the weight is indicated on a dial by a pointer controlled by pendulum counterbalances.

Weight-O-Graph—Scales so equipped have a light focused through a lens which projects the weight in magnified figures on a frosted screen, thus making the numbers easy to read (Figure 14).

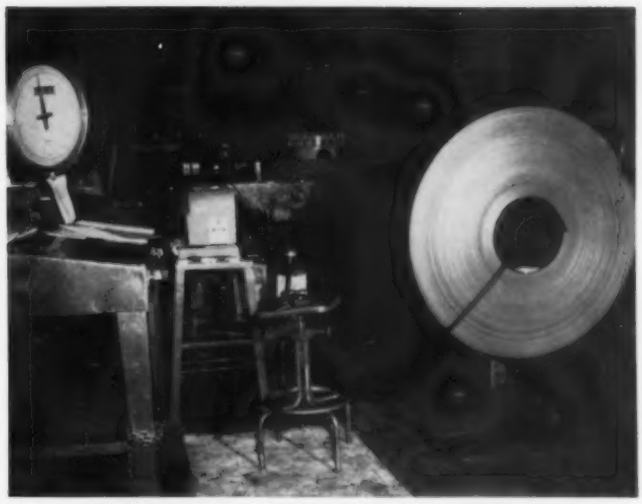


Figure 4—Heavy duty industrial scales require a permanent foundation on the location where they are used.

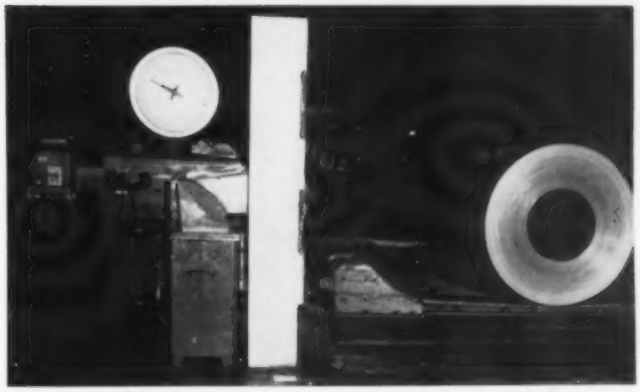


Figure 5—Coils are extensively weighed on heavy duty industrial scales.

Automatic printers—These are electronic devices which print the weight either at the scale or at some distant point (Figure 15).

Counters—See Figure 16. These are usually used on conveyor belt scales to automatically total the weight as it passes over the belt. The counter shown is used with the electronic load cell type scale as shown in Figure 8.

As can be seen from the pictures and descriptions of the various types and kinds of scales, their uses are varied and so are the maintenance problems. The scale repair department at Sparrows Point, which is the group that maintains this equipment, is headed up by a fore-

Figure 6—Motor truck scales are designed to handle trucks in transit.

man and assistant foreman, who report to the assistant superintendent of the mechanical department. The present working force consists of three scale repairmen leaders, eight scale repairmen, and ten scale repairmen helpers. This department is responsible for the installing, inspecting, adjusting and repair of all scales in the plant and in some cases of actually designing and building new ones. All scales are tested according to a regular schedule, some twice a month, some monthly, some quarterly, etc., depending on the type of scale, the accuracy that must be maintained and the importance of the scale in question. All scales are maintained within the tolerances prescribed by the National Bureau of Standards. This department has central shop facilities, located in the No. 2 machine shop, where many of the spare parts required for maintaining the scales are repaired, stored, etc., or new parts made from the original parts, from blueprints or from sketches made by this department. When necessary, for example, in the case of a wreck to a scale where a complete set of spare parts may not be on hand, patterns may be made in the mechanical department pattern shop, castings made at the plant's foundries and the final machining done in the No. 2 machine shop or in the scale repair shop. Because of the large area of the Sparrows Point plant, three other small shops or work areas are strategically placed in the plant; one in the steel producing division (blast furnace, coke ovens, etc.), and one in each of the major finishing divisions (tin mill and wire-pipe mills).

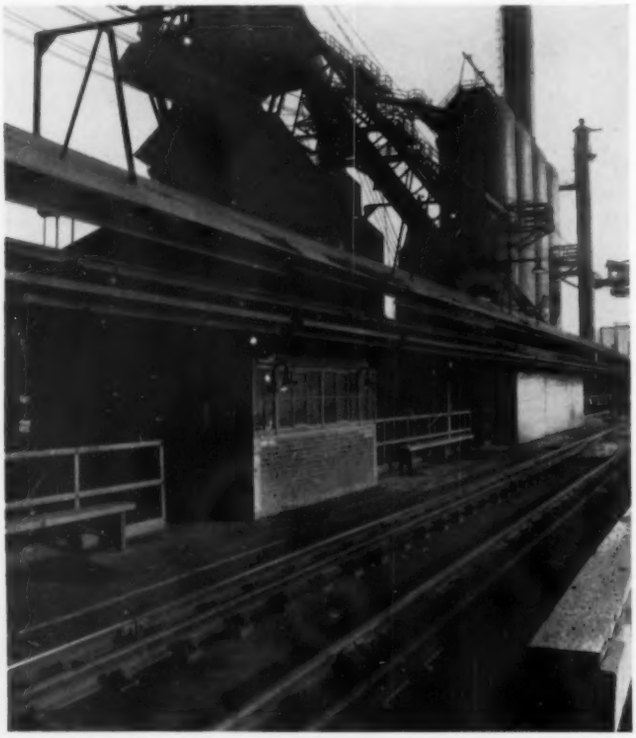


Figure 7—Railroad track scales are extensively used in the handling of raw materials.

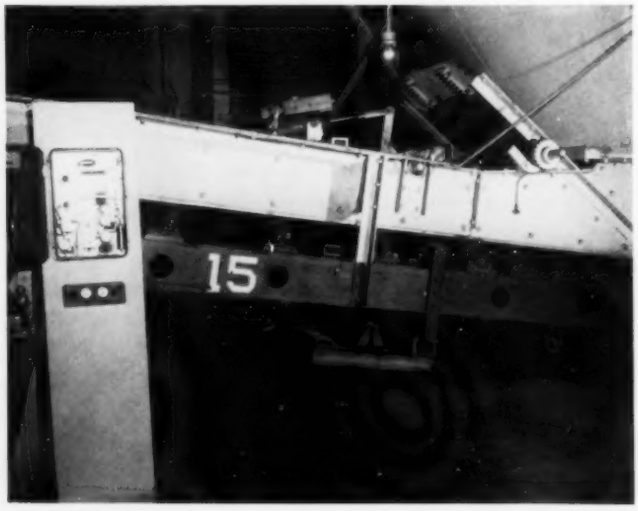
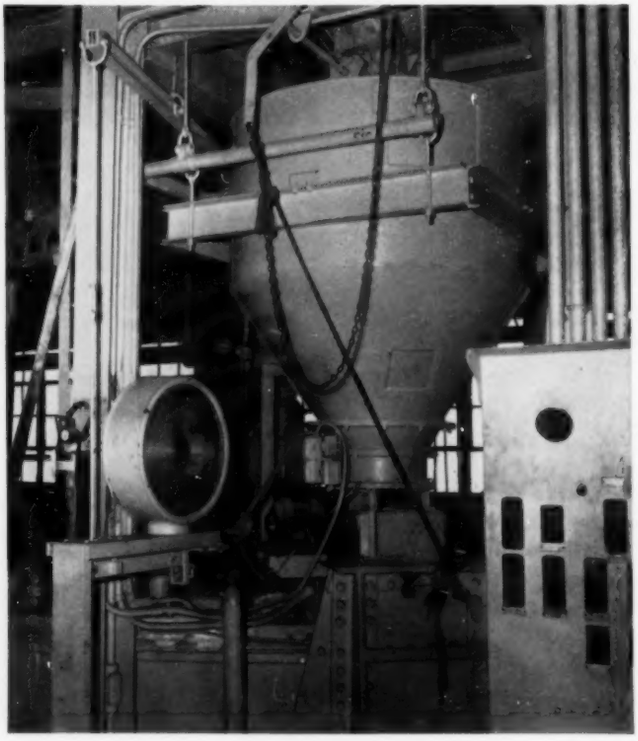


Figure 9—This conveyor scale is of the mechanical type.

Figure 8—Power scale, weighing sinter, has an electronic load cell.

Figure 10—Hopper scales are used for bulk materials.



While the scale repairmen are normally assigned to certain designated areas of the plant for testing and repairing all scales in that area, they are rotated in the various divisions on a six-month basis in order that they may be entirely familiar with all operations and with all types of scales that have to be repaired. The maintenance force is scheduled over a seven-day period (day turn only). However, in the event of a scale failure at night, men are called in to make repairs immediately.

The scale repair department makes its own scale pivots using 100 to 110 point carbon steel. The hardening of these pivots is done in electric furnaces in the blacksmith shop.

In the course of maintaining the scales, any part that is found not strong enough or not properly designed to do the job, is redesigned and altered so that the same failure will not occur again. All spare parts are given protective coatings or boxed, etc., and are stored and inventoried in a complete spare part file system.

One of the most important functions of the scale repair department is to work very closely with the engineering department, accounting department, and the operating department in the writing of specifications, the checking of blueprints, and the proper selection of any new scales that are to be purchased to do a particular job. They must pick the type of scale that will give the most accurate weighing with the least amount of maintenance and, if possible, pick one whose spare part requirements may be interchangeable with those which are already on hand or may be easily procured. Some of the pertinent items that are given detailed study in the purchase of a new scale are as follows:

1. The maximum load to be weighed at present and *in the future*. It often happens that a scale which was adequate for the job it was originally purchased to do, is found to be too light for the job several years later due to changes in methods of handling material, loading material on the scales, or changes in the speed and the capacity of the mill or the rate at which the product must be weighed. Therefore, it is well to try to predict the future and to get a heavy enough and large enough sectional capacity scale to take care of possible future needs.

2. How is the load to be applied to the scale? Will a tractor or crane be used or does the load roll down the ramp on to the scale, or will a conveyor be used to transport material over to the scale? These factors are important because the scale may have a heavy enough sectional capacity to weigh a given load once it is resting quietly on the scale, but where the load may be applied roughly and with severe shocks by cranes and tractors a heavier sectional capacity is needed.

Figure 11—Larry scales are mounted in a railroad car.

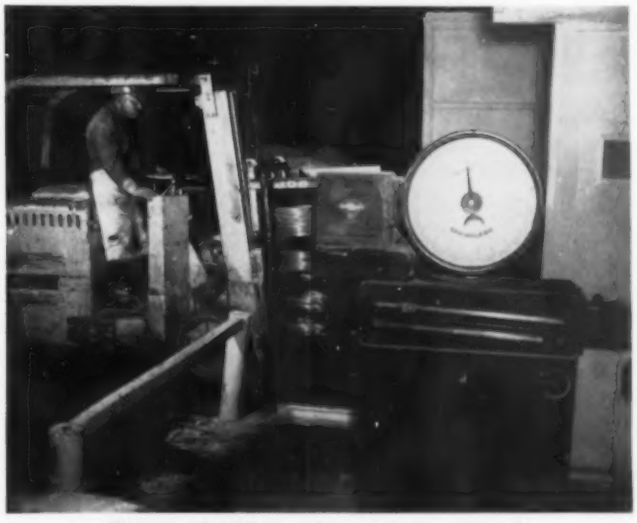


Figure 13—Dial scales are easy to read.

Figure 12—The weigh beam is perhaps the oldest measurement device.

Figure 14—Beam weights can be projected on a screen for easy visibility.

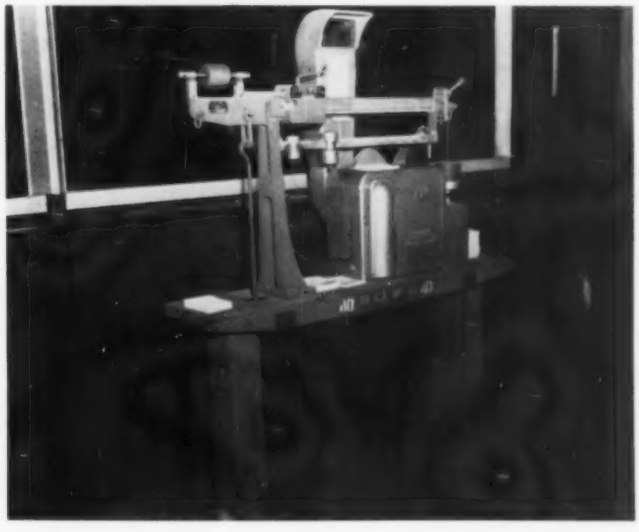


Figure 15—Printers give a permanent record of weight.

3. What is the future maximum length and width of the load to be weighed? It is important to determine the size of platform and how many sections of scale are required.

4. Is the scale to be used for shipment purposes or for measuring the production of the unit, or for both? If the scale is to be used for shipment, the proper type of weight recorder must be specified to meet certain customer demands, order and accounting department procedures, etc.; whereas, if it is to be used as a production check only, this may not be necessary.

5. Will it be necessary to "tare off" weight of dunnage. If blocks of wood or pallets, etc., are to be placed under the load, provisions must be made to "tare off" this material, or if a tractor is to be run on to the scale without releasing the load (in order to save time) the tractor and operator weight will have to be "tared off." This sometimes means a specially constructed weigh-beam as an adjunct to the cabinet dial in order to "tare off" such a large load. A scale of this type was illustrated in Figure 13.

In addition to the factors pointed out above, there are other physical characteristics of the scale area which must be considered, such as depth and size of the scale pit, ease of access to the pit, proper lighting and ventilation, etc. As an example of duplication of spare parts as mentioned before, the main levers on a new platform scale, say 20 x 6 ft, can probably be the same as those on an existing 10 x 6 ft platform scale. It is also well to try to specify the multiplication at the "steelyard rod" leading to the beam on dial type scales to conform with the existing multiplication factor of scales in the same mill. For instance, in the cold strip mill division at Sparrows Point, approximately 90 per cent of the scales have the same "steelyard rod" multiplication of 200 to 1 so that in the event a dial is badly damaged it can be replaced (as a temporary measure) within a few hours with another make dial or beam from another scale.

During the past few years efforts have been concentrated on replacing beam-type scales with dial and recording types, especially where customer shipments are

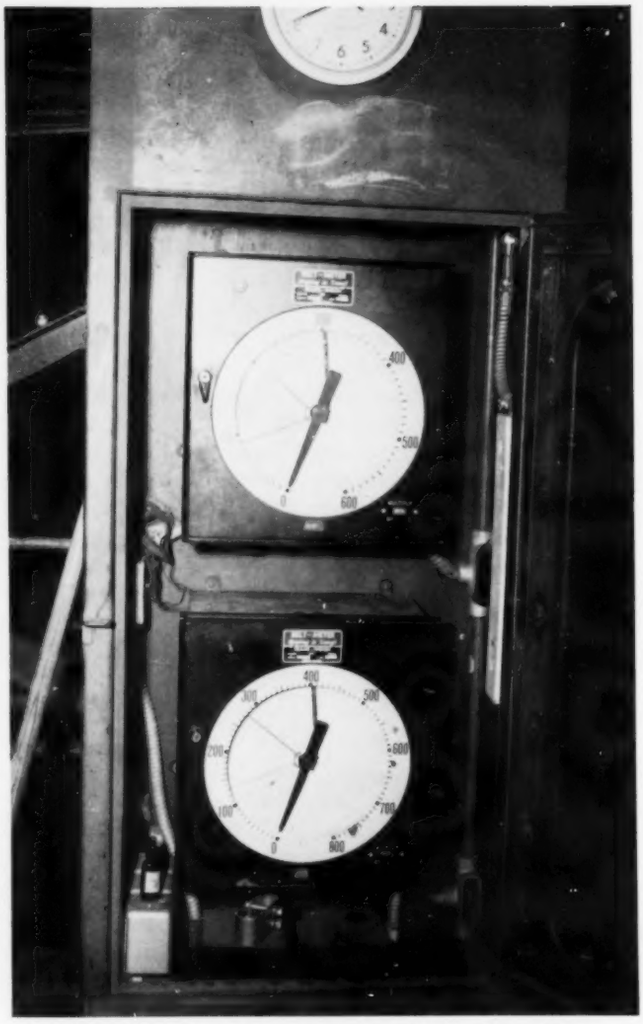


Figure 16—Counters can be used to total weight.

involved. A recent entry into the weighing field is that of the electronic scale and recorder which has been developed by various companies. While the various components that go to make up these scales have been in existence for some time, it is only recently that they have been put together into a complete scale. The compactness and ease of installation of this type scale is certainly a step in the right direction. An important feature of the electronic scale is its ability to record and print the weight information at some point remote from the scale. Only a few of this type of scale have been installed at Sparrows Point so far; however, additional ones are being installed which will be used in production weighing. This is being done cautiously until it has been definitely proven that they are easier to maintain and as accurate as the conventional lever-type scale. The maintenance of this type of scale may pose a problem, from the standpoint of qualified personnel to maintain the electronic unit.

To sum up, it might be said that the overall object of the scale repair department at Sparrows Point is to maintain all scales in the best possible condition at a minimum cost in order that accurate weighing within the prescribed tolerances may be done. This insures that the customer gets the full amount of steel that he orders and pays for, and also that the company is protected from any loss by not "giving away" steel because of inaccuracies of the scales.

In conclusion, however, there is one point that cannot be overlooked and that is that the scale is only as good as the "weigher." If you have a poor weigher, complaints and claims are inevitable, and the best of maintenance is to no avail.

DISCUSSION

PRESENTED BY

R. M. DENGLER, Assistant Superintendent Yard Dept., Bethlehem Steel Co., Bethlehem, Pa.

G. E. EVANS, Scale Repair Foreman, Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

W. R. ZEHNER, Assistant Superintendent Blast Furnaces, Bethlehem Steel Co., Bethlehem, Pa.

H. H. ANGEL, Electrical Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

WILLIAM MILLS, Foreman, Bethlehem Steel Co., Steelton, Pa.

C. E. PRITCHARD, Superintendent of Mills, Alan Wood Steel Co., Conshohocken, Pa.

WALTER R. O'MALLEY, District Manager, Harnischfeger Corp., Philadelphia, Pa.

L. V. YERINO, Design Engineer, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

JOHN LEWIS, Toledo Scale Co., Philadelphia, Pa.

R. M. Dengler: Do you have your electronic scales in operation long enough to know if your maintenance has been greatly reduced and to know if they will stand greater abuse?

G. E. Evans: We have not had our electronic scales long enough to give a true picture on maintenance, however, we have found that care must be taken not to overload the electronic cell beyond its rated capacity.

I am of the opinion that a cell scale will not stand greater abuse than a lever scale of the same rated capacity.

W. R. Zehner: What weighing is done for coke production? Where are belt scales used with load cells, and what is the approximate cost for, say, a 42-in. belt?

How often are the recording scales checked? Are these integrated coke weights used to check coke plant production?

G. E. Evans: The coal is weighed at the coal blending building on pneumatic belt scales, and is again weighed in the coke battery larry car hoppers on a track scale located under the coal bins. The weight is automatically recorded on a remote printer located in the foreman's office.

Coke production is calculated from these weights. The coke itself is weighed at the blast furnaces before it is charged into the furnaces. The recording scales are checked twice each month. Load cell scales are used at the ore sintering plant.

H. H. Angel: I would like to ask Mr. Evans if he has tried a scale attached to a crane hook?

G. E. Evans: We have tried several makes of mechanical crane scales, none of which have proved satisfactory due to hard usage and abuse. However, we are now using dynamometer crane scales as a check weight on coils of wire at the wire galvanizing and bethanizing. The operating people seem to be satisfied with their performance. These dynamometer scales are for check weighing only and are not used for shipping purposes.

William Mills: Mr. Evans made reference to the newer type scales that we are now hearing so much about, the electronic scale. The question I would like to ask Mr. Evans is, from the experience that he has had so far, is there a dividing line that he would recommend for use of electronic scales in heavy duty work within an industrial plant, and could he give us his reasons for that?

G. E. Evans: We have not had enough experience on the cell type electronic scale to make any flat recommendations. However, I would suggest that when considering the purchase of a heavy duty electronic scale, some thought be given as to how a test for calibration through the various ranges is to be made, and what large test weights are available. He should also see if the load cells are large enough to take the heaviest shock loading that can be foreseen.

C. E. Pritchard: What type of preventive maintenance program do you have in effect covering your scales? By that I mean what method do you have for protecting against corrosive atmospheres and the influence of corrosion on scales, actuating and housing members that are subjected to inclement weather conditions in open pits? That takes in both the electronic and the standard weight beam type scale.

Do you have any effective methods for eliminating the shock loading problem that we get into from time to time?

Do you weigh hot coils at the coiler discharge and if so what method is employed in coil weight identification and accumulated turn tonnage recording?

G. E. Evans: The pivots and bearing steels of all scales outside of buildings such as railroad track and motor truck scales are cleaned and packed with a light grease once a year, while the structural steelwork is inspected yearly by the mechanical department building and structures inspectors, who in turn send us a report of conditions found and recommendations as to what steelwork needs to be painted or replaced.

Where we anticipate shock loading on a scale, we usually specify a heavy sectional capacity scale as a means of combating shock. Where a dial is used, a dashpot is attached to the cabinet beam to help eliminate shock on the dial. We also specify a heavier deck plate as a means of spreading the shock across all levers.

Hot coils are weighed at the discharge end of the down coiler. The weight is recorded on a "rag sheet" by the weigher and identification markings are put on the hot coils with a special type of chalk.

Walter R. O'Malley: I would like to volunteer a little information about the electronic crane scale. Our corporation has a patent on the application of a load cell to a bottom block on a crane. We have approximately 100-plus installations around the country, ranging from 5 to 100-ton capacities. Every weighing problem must be studied carefully before application is recommended.

The installation is ideal if a new plant is being built and the crane is originally designed to accommodate the load cell in the block, because on an existing crane you have to spread the sheaves, groove your drum on a wider spacing, and other problems that arise on installing it.

However, thus far, for shipping rooms it has been an ideal setup. You can see that in picking up the load, you can weigh it without moving it to the scale in your building.

The accuracy obtained is a quarter of one per cent, for all practical purposes. We understand that this has been accepted by several states, and beyond that, as far as the Bureau of Standards is concerned, they have established certain tolerances. These must be met by any scale manufacturer, be they mechanical or electronic scales.

The crane scale can be equipped to take the armored cable from the block through a cable reel and either through a messenger system or another cable reel over to your cab location. You can either have a dial indicator in the cab, and the operator would then be depended upon to read that accurately, or through a printer, which would give you your printed measurement at all times. Another possibility is to have your recorder remote. This becomes quite an expensive proposition, however.

We have one installation in a foundry where we put the load cell in the block with the use of a magnet for weighing charges. The first problem that developed was the tearing of the armored cable by the irregular piles of scrap, and we had to relocate this load cell in the upper sheaves, which meant that weighing accuracy was complicated by the fact that only half the load was on the cell. However, we understand that even at the doubling of the error that this was still valuable to the foundry, and they have been satisfied with that.

These load cells are hermetically sealed. They are not affected by changes in the humidity. However, we are concerned about heat, and we are very cautious about application of these load cells in steel mills where we have excessive temperatures.

L. V. Yerino: In making a weighing on a crane, does the load have to be perfectly at rest or can you permit a bit of a swing in a hook block, or just how close do you have to keep that in order to get a good accurate reading?

G. E. Evans: The load should be in a plumb and stable state.

Walter R. O'Malley: We figure that you should allow, after you have picked up the load, eight to ten seconds before you print. It will not eliminate all the swing but it will keep the error down. However, each application is different. I have tried to highlight this crane scale and full particulars are available to those desirous of same.

John Lewis: I know of only one company in the United States which has produced a load cell scale accurate to one-tenth of one per cent under all normal temperature conditions. A temperature compensated load cell is used. This company is small and the man who handles it was partly responsible, I believe, for the setup of the weighing equipment at Republic Steel. Electronic weighing is not so much a scale problem as an instrumentation problem. That is to say, if the necessary know-how is available on how to compensate for temperature changes, etc., then an accurate weight will be indicated. Merely to hook up a cell and a black box and say, "Here are a few tubes that we are going to put in," will not necessarily given an accurate weight. However, it seems this company knows how to do it. The reason why I say this is because I have actually seen and tried their scale. The particular load cell on this scale is of 1000-lb capacity. I tested this scale and it was sensitive to four ounces in 1000 lb.

Now, an ordinary dial type indication was not employed, but the type of indication used was digital or numerical, much the same as a speedometer. This scale is extremely accurate, and it is now being accepted in the cotton industry for commercial weighing and I believe is the only electronic scale that is so accepted. I understand it has been tested by weights and measures in the South and throughout the cotton belt and has type approval. Of course, its capacity is relatively low. We cannot assume that there will be no condition of hysteresis present when a higher capacity load cell is employed, or when the tare weight is high compared with the net weight. After all, the load cell has the characteristics of a spring and there is a tendency to drift from zero.

Nevertheless it is my belief that accurate compensation for these defects will eventually mean that the load cell scale will largely supersede the high capacity conventional type lever scale.

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By CARL A. VOSSBERG, Chief Engineer, Southeastern Electronic Laboratories, Umatilla, Fla.

ELECTRO-NOMICS

▲ THE successful application of electronics in the heavy industrial fields usually requires the proper correlation of economics, dynamics and electronics.

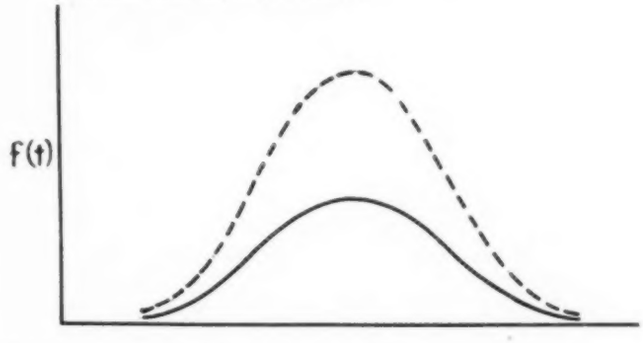
While everyone recognizes the need for rugged construction and industrialized components with conservative ratings, the internal circuitry often is not given the same treatment. The concept of dynamic electronics can play an important role in the reliability of electronic equipment in industrial fields.

Photoelectric detectors were probably one of the first devices using electronic principles applied to industry. While "door openers" have been eminently successful in banks, department stores, railroad stations, and the like, really heavy industrial applications have been comparatively limited. Dirt and other ambient factors plus lack of preventive maintenance are not conducive to faultless operation. Failures can often produce dramatic effects.

Instead of measuring absolute quantities—dependent on the whims of the source, condition of transmission medium, temperature, humidity, and stability of the detector—for many applications the rate-of-change is more useful than the function itself, and readily adaptable for varied purposes in the detection, measurement, and control of processes. In practice it is impossible for a signal to change instantaneously, and the problem then exists at what point to measure this change. The solution is found by measuring the rate at which the condition is changing, instead of measuring its absolute value. The device used is a differentiating circuit, producing an output proportional to the first time derivative of the input signal.

In Figure 1 is shown a common function asymptotically approaching the zero axis at either end. How wide is this function? It may be argued that the base line approaches infinity and as the amplitude increases, the apparent base line does increase almost without limit. The dotted curve has twice the amplitude of the solid with no changes in the abscissae. It certainly appears wider.

Figure 1—This common function approaches the zero axis at either end asymptotically.

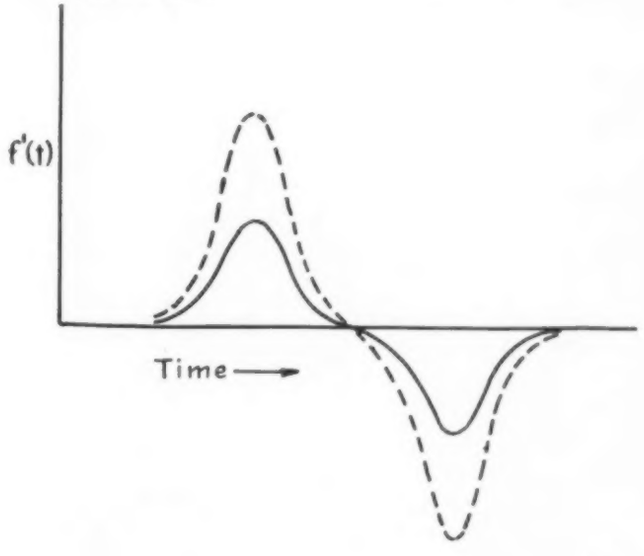


. . . . the concept of rate-of-change detection and measurement enables the application of dynamics and electronics to the solution of many industrial measuring and control problems . . . . advantages are reliability, stability, and performance independent of parameter changes . . . . .

Let us plot the rate-of-change, or the slope by differentiating these curves. The result is given in Figure 2. It will be noted that the peaks occur at identical points and if we can define the width of the plots as the distance between these peaks, then the determination of width will be independent of the amplitude of the original signal. This is a very important concept.

Many practical problems deliver a signal shown in Figure 3. The square wave signal, Figure 3a, can be an idealized force, energy or voltage excitation and the resultant output signal may approximate that in Figure 3b because of time lags and loss in resolution. It is no easy matter to determine the width of the original signal directly from Figure 3b, especially if the signal is aperiodic. However by differentiating the signal of Figure 3b, i.e., taking the rate-of-change, obtaining Figure 3c, the peaks occur at the start and finish of the original

Figure 2—Plotting rate-of-change of slope makes the width of plots independent of the amplitude of the original signal.



exciting signal and these with suitable modifications can be used to trigger auxiliary circuits, producing an output which is a faithful replica of the original signal. It can be seen that the points of maximum slopes are essentially independent of the amplitude of the original and modified signals.

Many applications require the measurement of a linear dimension of an object where any physical contact therewith is either undesirable or impossible—the material may be hot, ductile or abrasive or the required dimension may be inaccessible.

Consider the measurement of the diameter of a hot rod while it is being formed. See Figure 4.

The emanating radiant energy of the rod can be used to form an image by the lens on the aperture in front of the phototube. The image is scanned by the rotating mirror along the dimension to be measured. Under ideal conditions, the resultant phototube signal would have a rectangular wave shape as indicated in Figure 4a. Accordingly the duration of the time interval in which the radiation produced by the image impinges on the phototube will be a function of the dimension under measurement. Thus during a complete scanning interval, the ratio of the image signal interval to the duration of the complete scanning interval will be a measure of the object diameter, and independent of the scanning frequency as long as this is uniform over the cycle.

Because of optical imperfections, the image does not change abruptly at the boundaries of the rod, and the phototube contributes distortion and lag, the radiated energy may not be uniform, and the aperture must necessarily be of finite width. These all cause departures from the ideal wave shape so that the signal may be as shown in Figure 4b, with gradually sloping sides. However, the edges of the original object correspond with considerable accuracy to the points of maximum slope of the signal wave of Figure 4b.

The signal is then differentiated, delivering an output given in Figure 4c. A second differentiator will produce a signal shaped substantially as indicated in Figure 4d. The two successive differentiations result in a wave shape which crosses the axis at points corresponding to the maximum slopes of signal Figure 4b.

By suitable circuitry, the signal is modified into sharp pulses at the points of axis crossing and finally into a rectangular wave given in Figure 4e which is a reproduction of the ideal signal Figure 4a. A simple indicator serves to measure the average current which is propor-

Figure 3—A square wave is a very common problem.

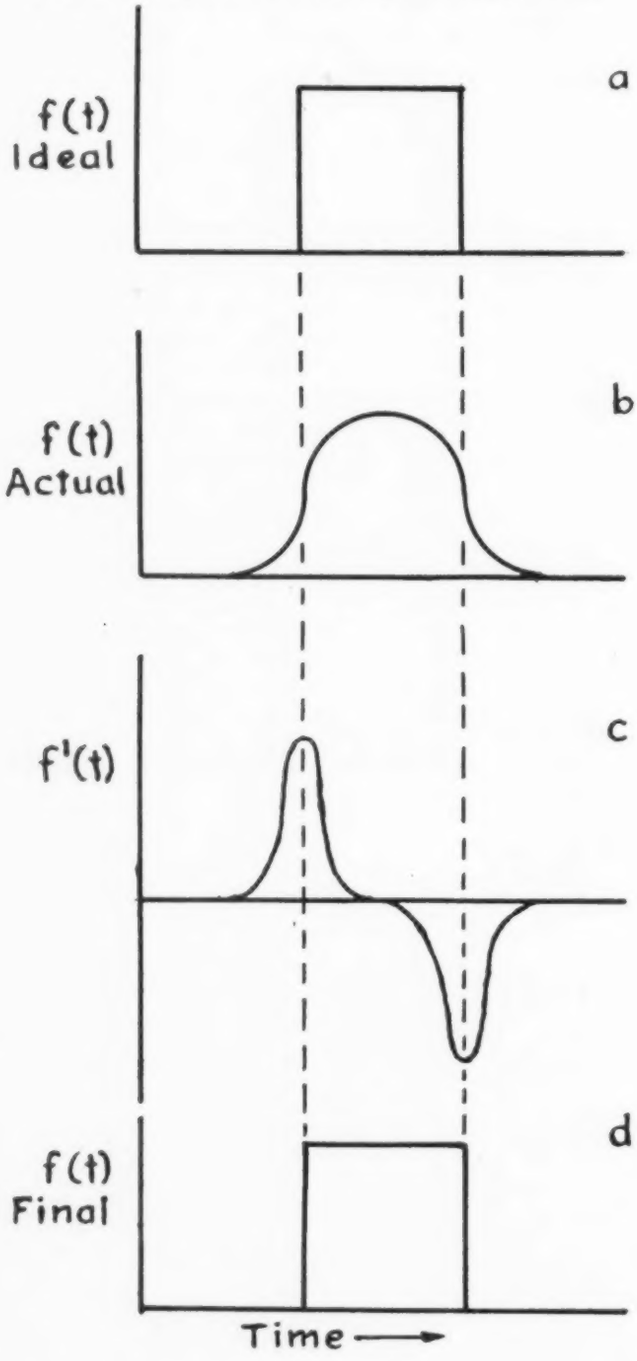
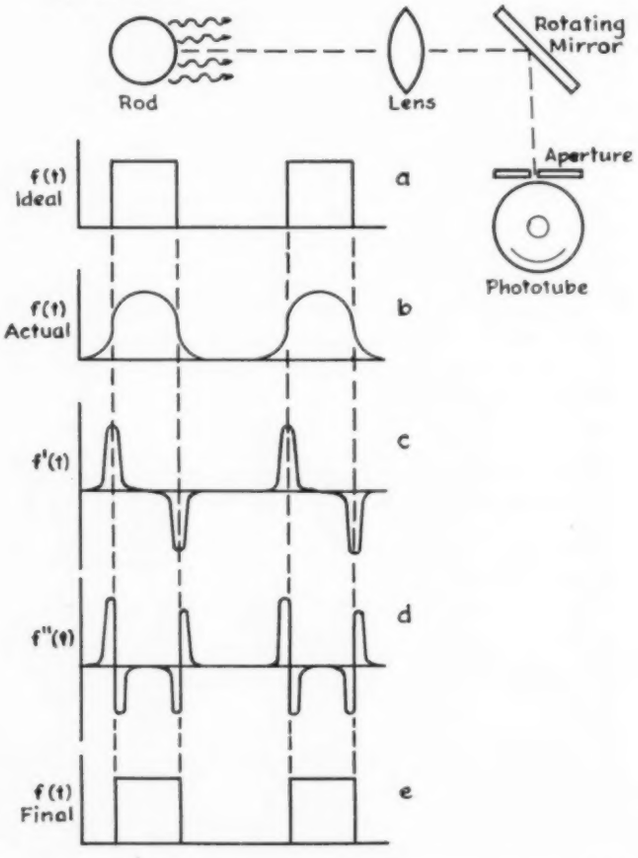


Figure 4—Schematic shows measurement of diameter of the hot rod.



tional to the image dimension. Again, it should be noted that the resultant signal is independent of the initial signal amplitude, therefore variations in rod temperature, dirt, aging of components, and loss in sensitivity will have no effect, because these will not alter the points of maximum slopes. Moreover, since the average magnitude of the current is determined solely by the ratio of the duration of the rectangular wave to the duration of the complete scanning cycle, this magnitude will not be affected by changes in the scanning rate.

Such a system has found wide use in measuring the width of hot steel strip up to 100 in. wide without contact at a distance of 15 ft from the strip. At this distance, the resolution is better than a few thousandths of an inch and for measurement of rod at five ft, a variation in diameter of a fraction of a thousandth can easily be determined. Using a lamp as the radiation source, a wire measurement gage has been developed with an inherent readability to 0.00001 in.

Similar principles can be applied for the measurement of the concentricity of an insulated conductor. The wire to be measured comprises an outer covering of insulating material which encloses a central conductor and may be in continuous longitudinal motion as in the course of its manufacture. X-rays project an image of

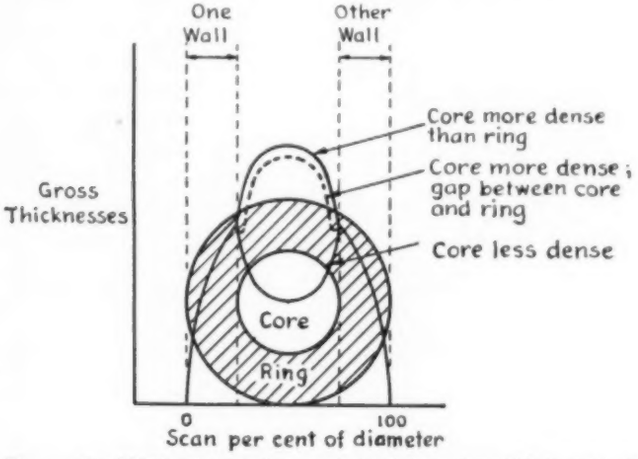


Figure 5—Method may be used to determine thickness of pipe.

the wire on to a fluorescent screen, casting a shadow which will have a dense central portion produced by the metallic core and two outer, less dense, portions produced by the insulating covering. The treatment of the scanned image is similar to that described above for the rod gage, and after proper manipulations, the four points of maximum slopes are used to deliver indicator outputs for each wall thickness, the internal diameter of the core and the concentricity—all without contact and independent of signal amplitudes.

A somewhat different scheme can be used for determining the wall thickness and eccentricity of pipe. In Figure 5 is given a plot of total cross-sectional wall thickness as the pipe is scanned, that is the source (x-ray) scans directly across the chords of a circular cross-section. A narrow beam of x-rays as it traverses a diameter of the pipe notes the corresponding integrated wall thickness, shown in the vertical direction. The solid line in Figure 5 is a plot of gross wall thickness across each chord of a hollow pipe or ring. The penetrated thickness increases rather rapidly at first as the beam enters the pipe and then decreases rapidly at the inner edge of one side, symmetrically repeating the signal as the beam passes the center of the pipe. Thus the curve has maximum slopes corresponding to the wall limits and by use of x-rays and detection, these points can be determined and the thickness of each wall measured. This is also useful for dissimilar materials and the core can be more or less dense than the outer covering. The dotted line plot is for a core of greater density than that for the ring. Another interesting application is on artillery shells where it is desired to inspect the copper band and its seat about a steel shell. The resultant curve for the case of an air gap is also given in Figure 5. Obviously the use of differentiators can be extended and applied to almost any system with demarcations or abrupt changes in characteristics along the interested dimension.

One of the simplest process controls comprises an infra-red detector which responds to a change in heat radiation due to the presence or removal of hot steel bars. The time function already has a rate-of-change or dynamic variation in the signal at the interested point. Industrial applications in iron foundries and steel mills impose severe restrictions, emphasizing the need for the utmost in reliability. Users of such equipment expect perfect performance without even a minimum of maintenance. By proper design, the sensitivity can be a thousand-fold that required for adequate operation, allowing sufficient margin for deterioration of the effective signal, because of dirt, fatigue, aging and other factors.

In other applications, these rate-of-change infra-red detectors operate water sprays, deflectors, blowers, blanking controls, and the like. The differentiators make operation independent of sensitivity and ambient conditions.

In a hot steel mill, the nose and tail of slabs leaving the roughers are rounded, forked or jagged and may give trouble in subsequent operations, so it is desired that these be cut off without waste and on the fly by means of a rotary shear.

A modified form of the infra-red width gage is used to measure the cross sectional width at one point across the strip and to continuously compare with a like measurement taken by a second scanner located one foot down the strip. At the nose, when the magnitude of the first scanned width approaches that of the second, a command is transmitted to a computer which starts a timing sequence as a function of the velocity of the strip. A position transducer from the shear compares its instantaneous position with that required by the computer and corrections are made as needed. At the tail, the initiating signal is made when the second scanner shows an integrated measured width less than the first.

Again, all measurements are independent of the temperature of the strip and water spots, scale, etc., are effectively cancelled out as the system is reset in the event the signals revert to the original values. A fork in the tail operates the trigger circuit causing it to effectively consider that point as a radical departure from the nominal width.

Still another variation lends itself to measuring the camber or twisting of the strip as it leaves the mill. This is especially important at the output of a hot strip

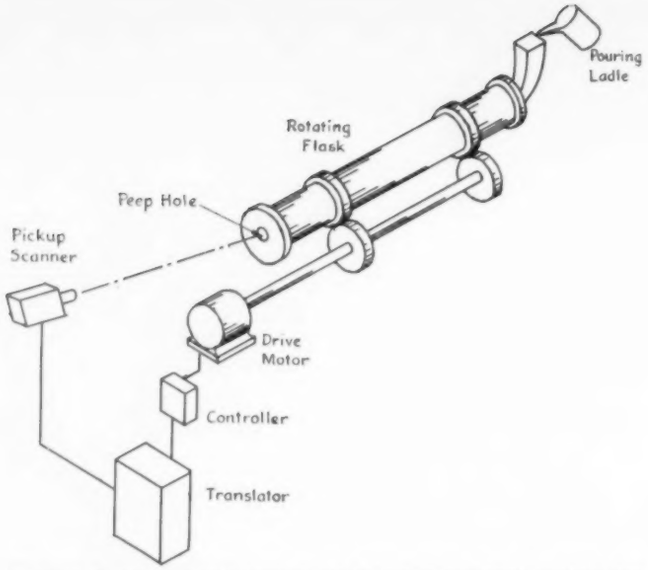


Figure 6—Schematic shows an interesting application for detecting solidification in a centrifugal casting machine.

mill as camber can cause cobbling, table run-offs, rubbing of guides, or improper coiling. As important as these effects are, more subtle cambering can still cause havoc in the cold mill during subsequent operations. A coil with camber—and particularly so at the weld—tends to ride the strip out of the guides and cobble in the cold mill. The camber is frequently erratic reversing itself many times, thereby forcing the operator to readjust his mill to accommodate for these variations and disturbing the steady state conditions and affecting the amount of on-gage material. Therefore the control of camber should be viewed from an overall plant operation rather than the limited scope of immediate effects in the hot mill. An instantaneous camber of $\frac{1}{32}$ in. in 10 ft can be detected.

A very interesting application of measuring time rate of change occurs in the detection of solidification conditions in centrifugal casting apparatus. Figure 6 is a schematic perspective view illustrating centrifugal casting machinery for making pipe.

The freshly poured molten iron cools initially (first phase) at a relatively rapid rate, as shown in Figure 7. When solidification commences, there is a marked decrease in the cooling rate as heat is generated during the exothermic solidification (second phase) of the iron. In fact the radiation may actually increase. After solidification is complete, the temperature resumes its relatively rapid descent (third phase), until it reaches room temperature. During the last phase there is no risk of deforming the casting and the machinery can be stopped. It is the purpose of the system to detect the transition points between cooling phases and to slow or stop the machine accordingly. This avoids unnecessary wear on the machinery and increases pipe production without risk of deforming pipe. Figure 7b is the first derivative of the curve in Figure 7a and the curve in Figure 7c is the second derivative. The second-derivative peaks operate trigger circuits to slow the machinery during the solidification phase, and to stop the entire operation when the casting enters the solid-cooling phase. In some instances this arrangement has a practical operating limitation, when the cooling cycle

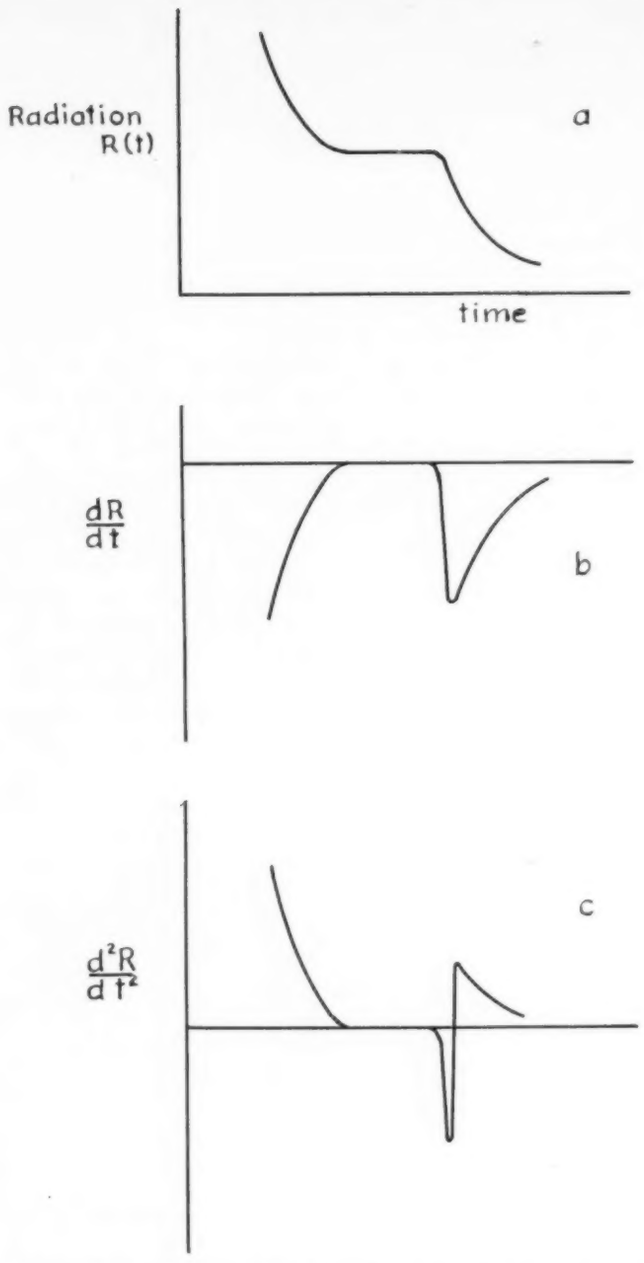


Figure 7—Instrument for detecting temperature is based on differentiating the cooling curve.

extends over a period of minutes because the long time-base of the cooling curve makes electrical differentiators difficult to construct.

To overcome the short time constants of the usual differentiating circuit, discrete temperature (radiation) increments are measured. A re-cycling timer, set for a duration longer than the resultant time increments during the first of the temperature run-down curve phase, repeatedly balances the system for a new incremental check of the rate-of-change. Approaching the second phase, the time increments become longer until a point is reached where the timer can time out and this information is used to operate the slow down contactor. This will be repeated with each successive cycle until the third phase period, where again the radiation will decrease more rapidly, and the time intervals will then be less than the timer period and the stop contactor will be operated. Alternatively, the

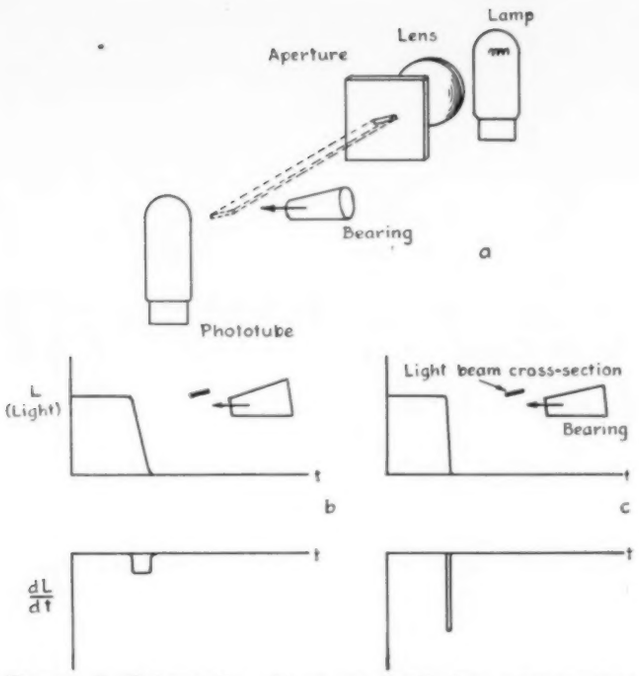


Figure 8—Schematic shows method for non-contact measuring of taper on roller bearings.

time intervals could be made equal, and the radiation increments measured and the corresponding values would serve to actuate the contactors. It must be emphasized that absolute values are not measured, but the rate-of-change of the excitation. Therefore different compositions, alloys, ambient conditions, and detector characteristics are without effect.

There are many extensions of this principle in the chemical field, where processes exhibit such varying rate-of-change characteristics. Note that the variable need not be radiation but any physical variation such as pH, index of refraction, turbidity, color titration results, viscosity or density could be used. The color of a furnace can be utilized to determine the condition of the charge, and the entire operation automatically regulated and controlled.

Differentiators are feasible in contour-coincidence systems. For example, one may desire to check, without contact, the taper of roller bearings. The bearings pass, at a uniform speed, through a narrow "board" of light (Figure 8) set at the angle of desired taper. Figure 8b shows the case for a bearing whose taper does not match the angle of the light beam. Because only one corner of this bearing enters the light beam, the phototube output and its differentiated signal will be as shown. A bearing with the correct taper cuts the beam at all points simultaneously, causing the light signal to terminate more abruptly when the bearing enters the beam. Figure 8c shows that the corresponding differentiated signal hits a sharp peak, indicating correct taper. The width of the differentiated pulse signal is a function of the correctness of taper and is independent of optical and sensitivity considerations.

Examples of dynamic electronics as applied to industrial problems have been given to illustrate the concept of rate-of-change detection and measurement. This principle can be extended to other applications with the attendant advantage of utmost reliability, inherent stability and performance independent of parameter changes.

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. . . . stone has its place in soaking pits but it must be used with judgment . . . . considerable care is required in construction and operation, particularly on pits with long walls . . . .

STONE PIT

▲ IT is a curious thing that we should be discussing a material which has been used by the metallurgical industry for centuries. Stone is known to have been quarried in the eastern states as early as the year 1650 and although unsuitable for use as a refractory under present day conditions, it was employed for building and lining furnaces, particularly blast furnaces, as late as the early part of the nineteenth century. Some of these early furnaces are still standing, one near Youngstown, Ohio having been built in 1802 by James and Daniel Heaton. This was the first blast furnace to be built in the Mahoning Valley, and the first erected west of the Alleghany Mountains.

However, the large quarries in the Waverly group in northern Ohio are the ones of primary interest to the metallurgical industry today. These quarries were opened and have been actively mined since 1840 with shipments to the steel industry starting just after the turn of the century. The early applications were for linings in the melting zones of grey iron cupolas and for bessemer converters. Records of the predecessor of what is today the Cleveland Quarries Company show shipments of stone in 1906 and 1907 to such mills as Illinois Steel Co., Wisconsin Steel Co., Republic Steel Corp., and Pittsburgh Steel Co. Incidentally, the stone was priced then at fifty cents per ton at the quarry with delivered prices of $2.00 to such places as Lackawanna, N. Y. and Mingo Junction, Ohio. The first record available of the use of stone as a soaking pit lining material is a shipment for that purpose in 1919 to the Monessen, Pa. works of the Pittsburgh Steel Co.

PROPERTIES OF STONE

The stone is a sedimentary material probably originating from the weathering of feldspathic rocks which have been carried away and deposited in layers under water with the clay forming minerals and the stone forming minerals being deposited separately because of their different specific gravities.

The stone from the geological formation known as the Waverly group is the material associated with soaking pit construction, and the quality suitable for soaking pit refractory is known as Berea firestone. This particular formation is a natural quartz rock formed in a broad band and to a considerable depth in several counties in northeastern Ohio.

However, the entire deposit is not suitable for use as a soaking pit lining. The best selection for refractory purposes lies usually at considerable depth, often as much as 100 to 200 ft beneath the surface, supporting a pressure from the overburden of from 15,000 to 30,000 lb per sq ft. This pressure, supplemented by the ce-

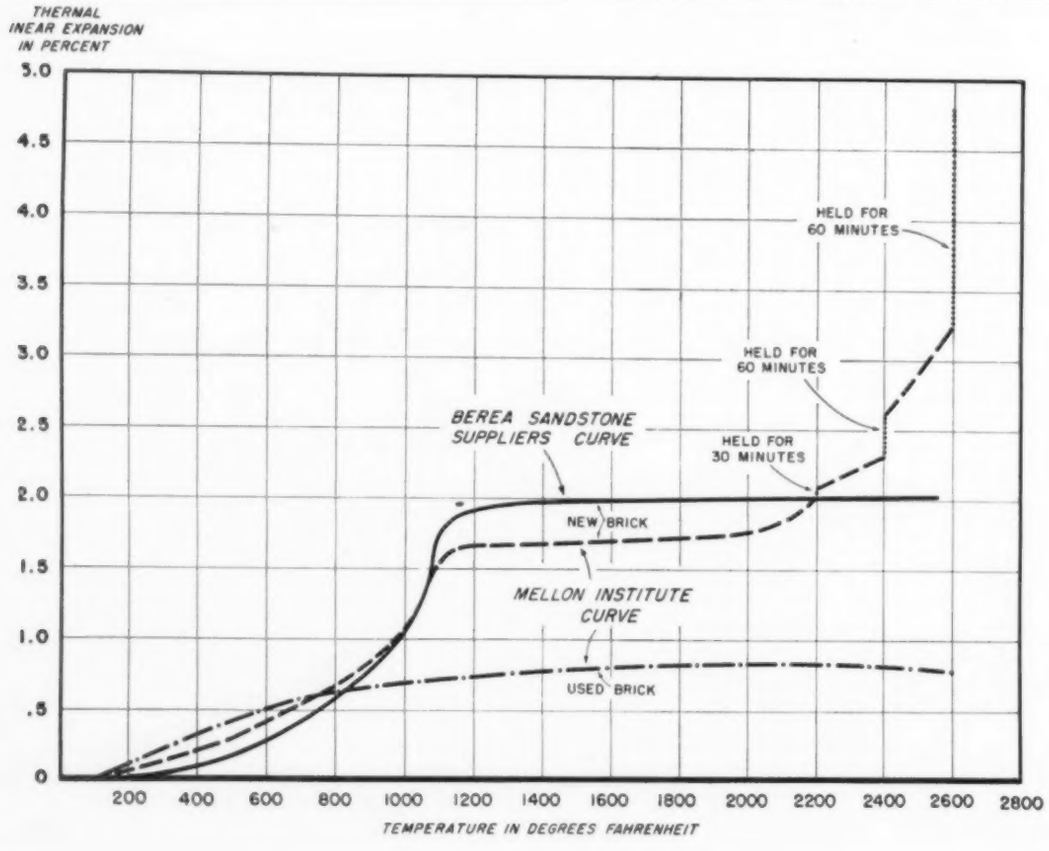

Figure 1 — Thermal expansion of the sandstone is appreciable.

By WILLIAM J. SCHARFENAKER, Masonry Superintendent
Steel Division, Ford Motor Co., Dearborn, Mich.

LINING EXPERIENCE AT FORD

menting action of interstitial matter, composed largely of amorphous silica, forms the bond by which the grains of quartz composing the stone structure are held together.

A typical chemical analysis of Berea firestone is shown in Table I.

TABLE I

	Per cent
Silica	93.3
Alumina	3.6
Iron oxide	1.4
Lime	0.6
Magnesia	0.5
Ignition loss	0.6
	100.0

This refractory type of sandstone differs from the usual sedimentary sandstone in that the binder is not calcium carbonate but rather amorphous silica. Finely divided iron carbonate, alumina and other compounds in small quantities are distributed through the mass and act as a further binding agent in holding together the grains of quartz. The resulting structure is rather open and porous.

The physical properties of Berea sandstone are shown in Table II.

TABLE II

Fusion point	3000 F (Cone No. 29)
Modulus of rupture, psi	1200 to 1400
Crushing strength, psi	8000 to 10,000
Average specific gravity	2.14
Porosity, per cent	18 to 20

APPLICATION OF SANDSTONE TO PIT LININGS

Some of the advantageous properties of stone which have resulted in its use in soaking pits include the fact that it is available in relatively large sizes which results in a minimum of often troublesome joints. Another and most important property and one which does not lend itself to scientific measurement is a property which can best be described as toughness. At normal soaking pit operating temperatures the stone develops this property to an extent which allows it to successfully live with the ingots and crane tongs and coke boxes and bottom cleaning and scraping tools which come in contact with it.

Stone used for soaking pit linings is usually of a size so that one header course will make up the full wall thickness on outside walls, and so that two headers will make up the full thickness of the heavy division walls between adjacent pits. The width dimension is usually one-half of the length for bonding purposes by the masons building the walls. Thicknesses are generally either 3 or 4½ in. being limited by the weight which a mason can handle.

The stones are generally supplied either sawed on two sides or six sides. Sawed-two-sides-stone is finished only on the two large flat faces with the other four faces being snapped on a break press and relatively rough. The sawed-six-sides-stone is finished on all six faces. The sawed two-sides-only-stone is a bit cheaper and the sawed-six-sides-stone is easier to handle. The choice varies somewhat depending on individual preferences and on conditions peculiar to the various plants and pit installations. Personally, I believe the two-sides-stone to be entirely adequate for relatively small pits with the six-sides-sawed-stone indicated for large pits with long walls where close control expansion joints becomes more critical.

DISADVANTAGES

As for disadvantages, one of the drawbacks in the use of silica sandstone is its large amount of expansion. A look at the expansion curves shows that the expansion at 2400 F (Mellon Institute results) amounts to almost 5 per cent. See Figure 1. This large amount of expansion brings up problems in laying up a sandstone wall.

Figure 2 — New soaking pits were installed in 1952 and 1953.

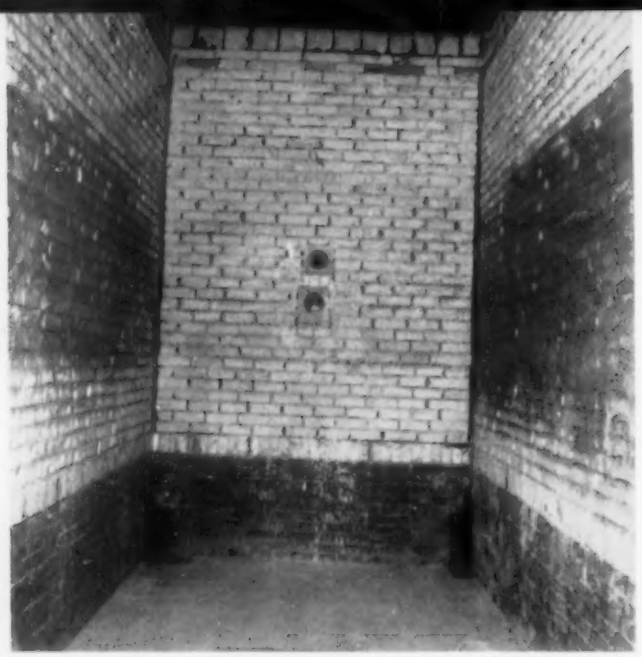

Figure 3 — The end hole side walls were built with a 3-in. invert.

Figure 4 — End of division walls and battery side walls have a 1¾ in. expansion joint at the ends of the walls.

Note that three curves are shown. The solid line curve is one which is taken from published literature and shows a quite rapid expansion taking place in the 600 to 1100 F range with a leveling off at 2 per cent total expansion. Our experience led us to believe the stone expands more than this, so samples of both raw and used stone were sent to the refractories fellowship at the Mellon Institute for thermal expansion tests. Standard ASTM heating rates were used with the exception of holding periods as shown. Substantial conformity exists up to 2200 F, but from this point on with the holding periods shown it becomes evident that a minimum of 5 per cent expansion takes place rather than 2 per cent. The salvaged used stone sample shows a smooth curve with less than 1 per cent expansion. Care must be taken to accurately leave just the right amount of expansion allowance, because if too much expansion is left, the walls will leak from one pit to another; and if insufficient expansion allowances is left, the wall will bulge or push out and spall.

Another disadvantage to be considered is the fact that Berea sandstone like other silica refractories has limited spalling resistance and care must be exercised while heating up a silica sandstone installation.

FORD SOAKING PITS

Our steel division installed a complete new soaking pit installation during 1952 and 1953. A detailed description was given by B. D. Barnes and H. E. Raaflaub in the 1954 Yearly Proceedings of the Association of Iron and Steel Engineers. Generally, the pits consist of five blocks of recuperative type furnaces with an over-all total of 20 holes available. The pits are twenty-five feet long, eight feet wide, and fourteen feet deep. They are normally fire-using mixed blast furnace and coke oven gas at 490 Btu per cu ft.

Original construction—The original construction of the outside walls consisted of 18 x 10 ⅛ x 3 in. Berea sandstone layed all header (18 in. way), backed up with 4½ in. of 2300 F insulating firebrick followed with 2½ in. of 1800 F insulation block against the shell.

The division walls were 40½ in. thick and were built

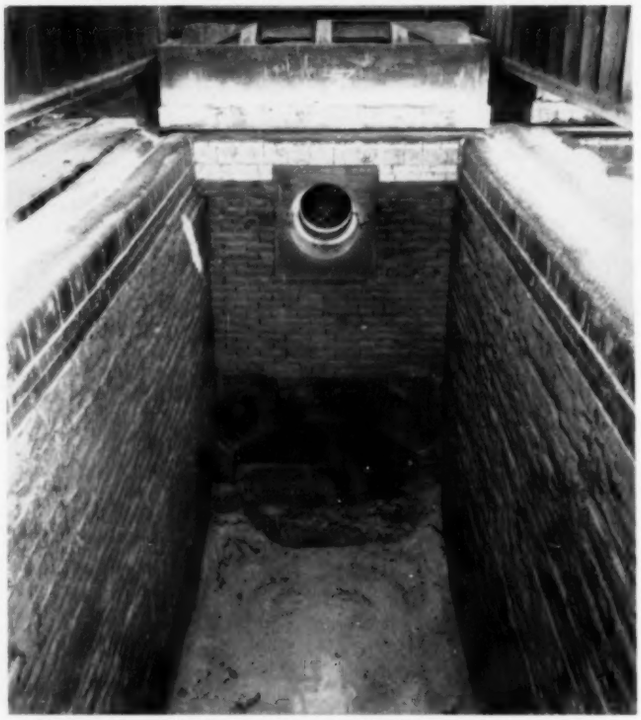

Figure 5 — All stone was sawed off on only two faces.

Figure 6 — Fireclay and chrome ore mortar were used in laying the stone.

Figure 7 — Movement occurred on long walls.

Figure 8 — Expansion caused buckling in wall.

Figure 9 — Note separation as wall expands.

Figure 10 — Upper portions of division walls have a tendency to split open at the quarter points.

Figure 11 — There was a fair amount of coping tile trouble.

Figure 12 — There was also the usual share of pit floor troubles.

using 20¼ x 10 ⅛ x 3 in. Berea sandstone. All stone were sawed on only the two large faces. The stone was layed up using the traditional mixture of fireclay and and chrome ore mortar. The expansion was made up using corrugated cardboard, two pieces for stone layed header and four pieces for stone layed stretcher. The ends of division walls and battery side walls had a 1 ¾ in. expansion joint at the ends of the walls. The end hole side walls were built with a 3 in. invert and tie plates in the bed joints anchored to the shell. See Figures 2 to 6.

Running repairs—The experience with these pit linings in all likelihood has not been particularly unusual. They were brought up to temperature very carefully after original construction on a planned schedule covering a total of eight days. The original warm-up

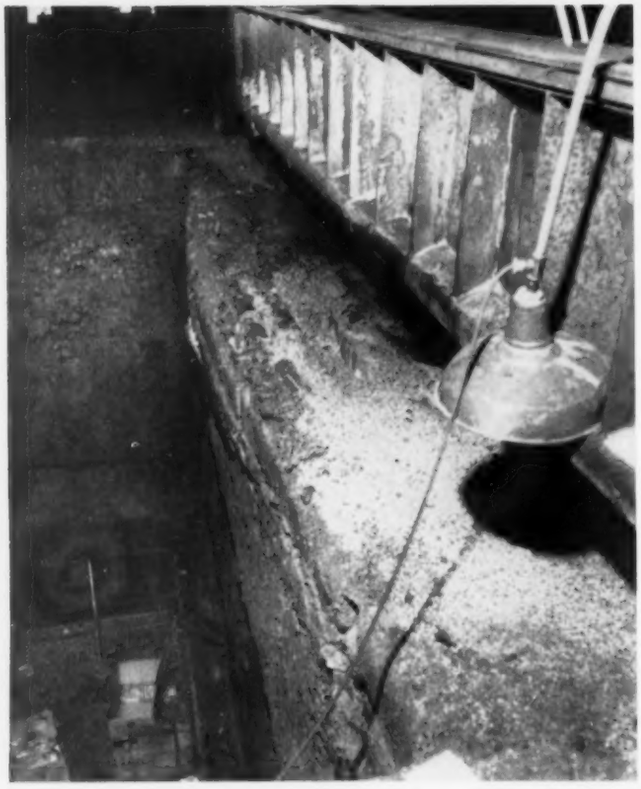

Figure 13 — A relining program was eventually necessary.

was uneventful except for some movement and straightening out which occurred on the long outside walls of the end holes on each battery. From here on we had at least our fair share of coping tile replacements and burner block, pit floor, slag line, and bridge wall troubles of the sort shown on Figures 7 to 13. The outside walls gradually become more and more convex and move further away from the shell. The upper portion of the division walls showed a tendency to split open at the quarter points where the joints in the stonework are broken either at the center of the wall or 10¼ in. from either of the hot faces. The possibility that these long walls were under excessive compression from the ends led us to send stone samples for expansion determinations previously described. Close examination of the pits revealed that all of the original expansion joints had completely closed, and examination of the structural binding also showed evidence of heavy compressive forces in these walls. Accordingly the expansion allowance on repair jobs was increased to approximately 5 per cent. To date we have experienced no failures of the sort described above in any of the walls built with the increased expansion allowance.

Relining practice—Gradual deterioration of the pit bodies along with the development of other problems in the bridge wall downtake, flue, feather walls, recuperator, burner, and jet pump areas eventually dictated a relining program which is now essentially complete. Various modification in details of construction were incorporated in these relines from the practice which was employed in the original construction.

Expansion practice—Expansion allowance was approximately doubled and wooden paddle boards were used to gage these joints to assure accuracy. Boards ⅜ in. thick were used between all 10 ⅛ in. headers, and boards ¾ in. thick between all 20¼ in. stretchers.

Figure 14 — A highlift was used in the pits.

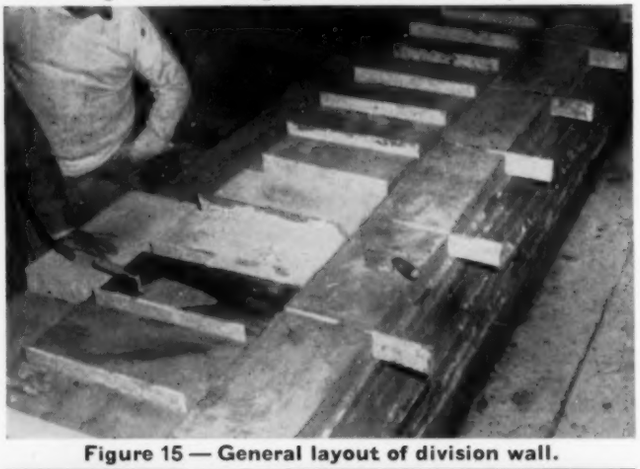

Figure 15 — General layout of division wall.

Figure 16 — Boards ¾ in. thick were used between all 20-in. stretchers.

Figure 17 — Layout of outside wall shows arch.

Figure 18 — Closeup shows springing at bottom front corners of outside wall arch.

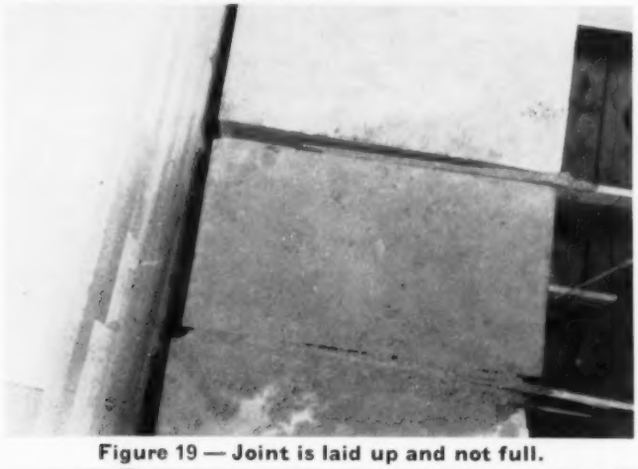

Figure 19 — Joint is laid up and not full.

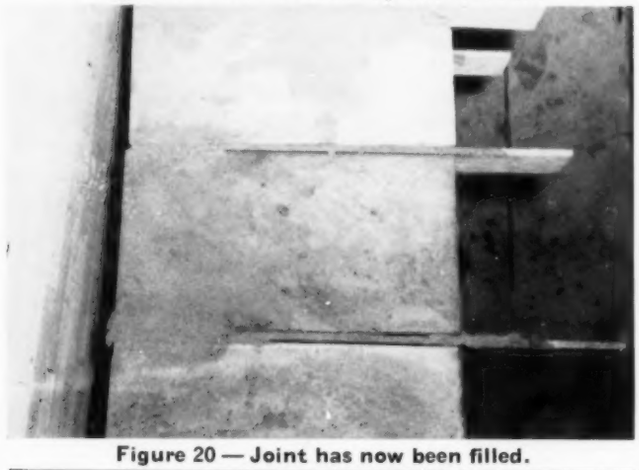

Figure 20 — Joint has now been filled.

Figure 21 — Men are spreading bed joint on outside wall.

Paddle boards were left in four or five courses behind to allow time for the mortar to set up before pulling them. Of course, the paddle boards had to be pulled out of the tie stone in every other course on the division walls. Waterproof paper was rolled out over these courses to keep the joints open before spreading mortar for the next course.

Mortar—Examination of stone removed on the early repair jobs show nothing but chrome ore left in the joints with the fireclay portion of the original fireclay-chrome ore mortar having been absorbed into the stone. The result was a highly glassy zone ¼ to ½ in. thick adjacent to each joint. This was felt to be undesirable so a change was made to a pyrophyllite base mortar. It eliminated the development of the glassy zones and the practice was extended to the relines. A good grade of silica clay no doubt would accomplish similar results.

Division walls—The mortar and expansion joint practice previously described applies to all walls of the pits. Other modifications in the construction of the division walls included elimination of the expansion pocket at the ends of the walls in favor of bonded construction, and substitution of semi-silica brick in place of stone in the upper portion of the walls above the tops of the ingots. The hope here is to retain the toughness of stone in the lower portion of the walls and to increase spalling resistance in the upper portions of the walls which are subject to wider temperature variations and direct flame radiation. Incidentally, we are confident semi-silica brick will do well in these upper areas since it has performed well in the covers.

Burner walls and opposite walls—No particular troubles had been experienced with the burner walls so no further changes were made in them. On the walls opposite the burners, however, scale and drips from the ingots had seriously eroded the stone so a substitution was made in the top three feet to dense super duty firebrick.

Outside walls—Major modifications were made, however, in the construction of the long outside walls of the end pits. As mentioned earlier, these walls were built with a 3 in. invert and tie plates fastened to the shell. They began to move away from the shells early and continued to do so throughout their life. The only evidence of tie plates at tear down was the clips on the shell. The plates had all oxidized and been absorbed into the wall materials. As a result, they were abandoned and not used on the relines. The amount of invert was increased to 6 in. with full joints at the cold end and open joints at the hot face. In the belief that a wall with an invert is an arch laid on its side and that an arch needs firm skewbacks, the expansion pockets at the ends of the walls were eliminated in favor of full bonded construction. The pockets left between the main wall and the insulation brick because of the invert were filled with standard 2700 F castable. These walls have all remained tight against the shells during warm up and have shown no movement to date. See Figures 14 to 22.

The warm-up schedule used calls for a 50 degree F per hr temperature rise to 800 F and then 30 F per hr rise to 1200 F with an 8-hr soaking period at this point followed by a 50 degree F per hr rise to the operating temperature of 2400 F followed by another 8-hr soak before charging the pits. The total elapsed

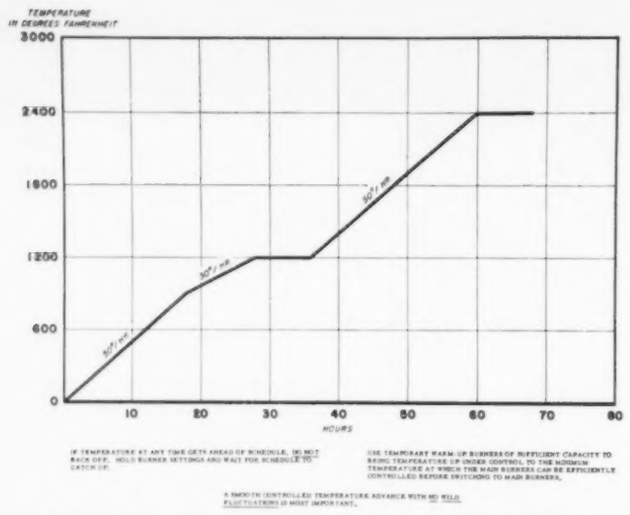

Figure 22 — A smooth warm-up schedule is used.

warm-up time was 68 hours and we have seen no ill effects to date as a result of using this schedule.

To sum up, stone has its place in soaking pits, but it must be used with judgment. It requires considerable care in construction and operation, particularly on pits with long walls.

DISCUSSION

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F. R. PULLEN, Fuel Engineer, Bethlehem Steel Co., Johnstown, Pa.

WILLIAM J. SCHARFENAKER, Masonry Superintendent, Steel Div., Ford Motor Co., Dearborn, Mich.

F. B. Bevelheimer: Part of our original troubles originated from the high temperatures we carry in our soaking pits. We are heating our ingots to about 2440 F rolling temperature. We feel that at times our temperature in our pits has exceeded that by quite a margin. We feel that with the curve as we now know it on expansion, the high temperatures that we are experiencing in our pits is the one thing that has contributed more to our troubles in an early stage than any other.

We are finishing on our mill, on slab ingot in the neighborhood of 2050 to 2150 F after 18 to 20 passes on a blooming mill.

John Craig: As we get into the longer or larger pits, we all have some of this expansion problem. We experienced this after approximately two and a half years. I do not know just how long it was before you experienced it. We have gone into somewhat the same type of program, leaving more expansion, and in that case getting better results. We have noticed in doing some bond changing, and changing some of the mortars, that we do not have the bulging below the top tile. I believe that is where you have yours, five or six feet below the top tile. We do not have that bulging and peeling.

F. R. Pullen: This excellent paper not only brought to light some of the problems encountered in this particular soaking pit installation, but apparently uncovered some new scientific data with regard to thermal expansion characteristics of silica firestone.

Early in 1951, six five-hole batteries of pits similar to those installed in Ford went into operation at the Johnstown plant of Bethlehem Steel Co. These pits are 7 ft 6 in. wide by 20 ft 6 in. long by 11 ft 9 in. deep. Prior to this installation, our experience with silica firestone pit linings was rather limited. Experimental linings had been put in on some existing soaking pits several years previously. The results obtained from these tests were inconclusive and the original installations were replaced with silica brick.

During the engineering stages of the new installation at Johnstown, considerable thought and effort were devoted to materials of construction. As a result of the discussions with the various manufacturers and with others in the industry, we installed the six batteries in the following manner: two batteries were built with silica firestone throughout, two additional batteries were built with silica brick throughout, and the remaining two batteries were built with silica firestone division walls and silica brick on all of the outside walls.

We did not experience the shelling effect in our pit that was experienced at Ford. This may have been due to minor differences in construction as well as differences in the actual dimensions of the pit. Our operating experience indicated that the silica firestone walls and the silica brick walls both gave about the same performance. However, when it came to repairing the walls, our masonry department expressed a definite preference for the silica brick construction. Therefore, when it came time to add another five-hole battery to the existing installation, the entire battery was built of silica brick. After completion of the new battery of pits, we started a rebuilding program on the original six batteries. These will be rebuilt with basic brick to the slag line and silica brick from that point to the top of the wall, in both division walls and outside walls.

William J. Scharfenaker: I think it might be in order to make a comment since Mr. Pullen brought it up, of brick versus stone. In trying to determine what is best, on the relining program which now is essentially complete, one battery was put in with semi-silica brick and the others have gone in as described in the paper.

As far as the maintenance approach to the problem, time required and so forth, we found no significant difference whatever when we went through our rebuilding program. As you noticed, our pits are four holes to a battery. We took the complete battery down, cleaned out to the shell and did other accessory work at the same time, with some repairs in the downtakes and removal of slag accumulation in the tunnels. Probably an average of 18 in. was found in the tunnels and had to be removed and the floors repaired. Also we took the feather walls down, cleaned the recuperators and rebuilt the feather walls, but as far as the downtime required and the manhours required to do the job, we found no significant difference between brick and stone.

We established a pattern. We would take the battery down on Saturday afternoon and light up the following Friday.

TENTATIVE PROGRAM

AISE SPRING CONFERENCE

AUSPICES OF ROLLING MILL COMMITTEE

THE NETHERLAND HILTON HOTEL CINCINNATI, OHIO

April 29, 30, May 1, 1957

MONDAY, APRIL 29, 1957

8:30 am—REGISTRATION—
Fourth Floor Foyer, The Netherland Hilton Hotel

9:00 am—ROLLING MILL SESSION—
Pavillon Caprice

Chairmen: Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

R. C. Schaefer, Superintendent Hot Strip Mill, Wheeling Steel Corp., Steubenville, Ohio

"Recent Developments in Slabbing Mills," by H. J. Kalberkamp, Chief Engineer, Mesta Machine Co., Pittsburgh, Pa.

"Roll Design for a Combination Wide Flange Beam and Structural Mill," by Herman E. Muller, Superintendent Roll Dept., Inland Steel Co., East Chicago, Ind.

"Mechanical Manipulation in Bar Mills," by E. C. Peterson, Vice President, Rolling Mill Equipment Div., Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

9:00 am—ELECTRICAL SESSION—
North Hall

Chairmen: R. G. Nolan, Electrical Engineer, Granite City Steel Co., Granite City, Ill.

D. C. McCrady, Superintendent Electrical Dept., Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

"Electrical Drive System for a High Speed Combination Rod Mill," by A. F. Kenyon, Advisory Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., and H. J. Oakes, Senior Engineer, Systems Control Dept., Westinghouse Electric Corp., Buffalo, N. Y.

"Electrical Equipment for a Modern Rod Mill," by E. L. Anderson, Superintendent Electrical Dept., Bethlehem Steel Co., Johnstown, Pa.

"Methods of Control of Strip Thickness on Hot Strip Finishing Mills," by R. A. Phillips, Control Systems, Analytical Engineering Section, General Electric Co., Schenectady, N. Y.

2:00 pm—ROLLING MILL SESSION—
Pavillon Caprice

Chairmen: F. G. Kredel, Chairman, Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio

A. M. Cameron, Superintendent Blooming & Bar Mills, Atlas Steels, Ltd., Welland, Ontario, Canada

"American Steel and Wire's New Rod Mill," by W. V. Magee, Assistant Chief Engineer, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio

"A Combination Mill for the Rolling of Strip, Rods and Bars," by Ernest E. Davis, Superintendent of the Hot Mills, Carpenter Steel Co., Reading, Pa.

"Algoma's Combination Bar and Strip Mill," by W. H. Mulflur, Division Superintendent, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada

2:00 pm—COMBUSTION SESSION—
North Hall

Chairmen: R. A. Lambert, Superintendent Steam & Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

F. B. Bevelheimer, Power & Fuel Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Billet Heating-New Johnstown Rod Mill," by F. R. Pullen, Fuel Engineer, Johnstown Plant, Bethlehem Steel Co., Johnstown, Pa.

"Rapid-Acceleration Heating Features on the Soaking Pits at Fairless Works," by J. Leo Hagan, Fuel Engineer, Rolling Div., United States Steel Corp., Fairless Works, Fairless Hills, Pa.

"Recent Developments in Metallic Recuperators," by Thomas E. Dixon, Vice President, and Heinz A. Kuhne, Vice President, Griscom-Russell-Schack Co., Inc., Pittsburgh, Pa.

TUESDAY, APRIL 30, 1957

9:00 am—ROLLING MILL SESSION—
Pavillon Caprice

Chairmen: R. P. Schuler, Superintendent, Cold Strip Dept., Inland Steel Co., East Chicago, Ind.

E. O. Reese, General Superintendent, Flat Rolled & Tubular Mills, Youngstown Sheet & Tube Co., Youngstown, Ohio

"Turn-up and Turn-down in Hot Rolling," by G. E. Kennedy, Technologist, and F. Slamar, Research Engineer, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

"Resume of Operating Methods of Canada's Continuous Hot Strip Mill," by R. J. Barry, Superintendent, Plate & Strip Mill, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

"The Planetary Hot Strip Mill and Its Uses," by T. Sendzimir, The Sendzimir Co., Waterbury, Conn.

9:00 Am—MECHANICAL SESSION—
North Hall

Chairmen: H. R. Knust, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.

Charles H. Good, Jr., Chief Engineer United States Steel Corp., Duquesne Works, Duquesne, Pa.

"Current Status of Spindle Slipper Lubrication," by Wayne G. Ritter, Trabon Engineering Corp., Pittsburgh, Pa.

"Primary Mill Roll Neck Bearings and Their Protection," by George Sackerson, Superintendent, Blooming Mills, Billet Mills, Rail Mill, Splice Bar and Tie Plate Shops, Bethlehem Steel Co., Lackawanna, N. Y.

"Crowned Tooth Gear Type Couplings—Their Development and Application with Particular Reference to the Steel Industry," by Frank W. Zurn, Vice President—Sales, American Flexible Coupling Div., Zurn Industries, Inc., Erie, Pa.

2:00 pm—OFF-THE-RECORD ROLLING MILL PANEL DISCUSSION—Pavillon Caprice

Moderator: Don C. Horsman, Plant Superintendent, Continental Steel Corp., Kokomo, Ind.

The following topics will be covered in this panel discussion:

(1) Guide application and materials on rod and merchant mills (including roller guides).

(2) Cooling rod and merchant coils (finishing temperatures, cooling methods, cooling pipe applications, cooling in coilers, cooling on conveyor, etc.).

(3) Time-saving ideas in roll changing.

(4) Practices used in polishing finishing passes in rod and merchant mills.

(5) Cutting deformations for reinforced concrete lug bar.

7:00 pm—INFORMAL STAG DINNER—
Hall of Mirrors (3rd Floor)

Speaker: R. L. Gray, President, Armco Steel Corp.

WEDNESDAY, MAY 1, 1957

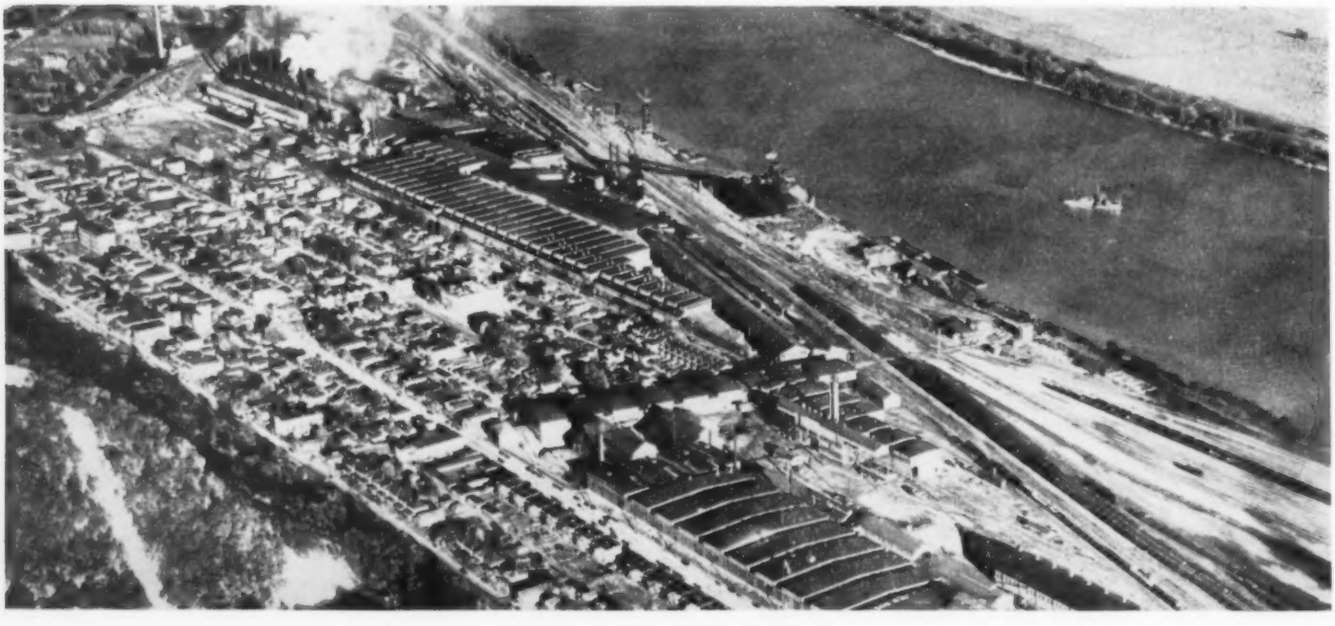
8:30 am—INSPECTION TRIP—

Detroit Steel Corp., Portsmouth Div., Portsmouth, Ohio. Buses will leave from Netherland Hilton Hotel

Hotel Reservations

For hotel reservations, write directly to the Netherland Hilton Hotel giving time of arrival, type of accommodations desired and period of stay. Reservations should also state that they are for the 1957 AISE Spring Conference.

General view of Detroit Steel Corp.'s Portsmouth, Ohio, plant



. . . . paper read at School of Mines and Metallurgy, University of Minnesota . . . .

IRONMAKING IN JAPAN

By
DR. KAMEKICHI WADA
Director, Yawata Iron & Steel Co., Ltd.
Superintendent,
Blast Furnace and Coke Oven Dept.
Yawata Works
Kyushu, Japan

▲ THE total output of pig iron production in the world in 1954 was 172,000,000 tons, of which more than 5,000,000 tons was made by Japan, ranking sixth on the list.

Prior to the end of World War II, the peak production of pig iron in Japan was 4,716,425 tons in 1941. Right after the end of the War, only three blast furnaces of Yawata Works were operating and pig iron production was very low. Production has gradually increased, however, since start of raw material imports in 1948. See the following:

Year	Tons
1950	2,383,758
1951	3,476,482
1952	3,669,723
1953	5,037,588
1954	5,079,785

In 1955, as many as 21 of the 35 blast furnaces were able to operate again.

The daily iron production per furnace in 1953 averaged 841 tons in the United States, 323 tons in England, 439 tons in West Germany, 301 tons in France, and 627 tons in Japan. Thus, Japan ranks second to the U. S. A. in output of blast furnace.

The production schedule of iron and steel for the fiscal year of 1955 is as follows:

		Tons
Pig iron:	Blast furnace	5,280,000
	Electric furnace, etc.	385,000
	Total	5,665,000
Steel ingots:		
	Open hearth	7,678,000
	Converter	440,000
	Electric furnace	1,265,000
	Total	9,383,000
	Ordinary finished steel	6,380,000
	Special steel products	330,000

Of the above figures, about 4,400,000 tons of pig iron will be consumed in open hearths under the mixing ratio of 50 to 60 per cent, and the remainder (660,000 to 880,000 tons) will be foundry iron.

PRODUCTIVITY OF BLAST FURNACES IN JAPAN

Compared with prewar days, the average output of pig iron per blast furnace in Japan has been increased by 50 per cent. For example, at Kukioka furnace at Yawata Works, which had actually been producing 900 tons on the average per day before the War, production averaged 1300 tons per day in 1954. Average production per sq ft of hearth area per day, which had been 2800 lb before the war, was 3800 lb in 1954. Kukioka No. 4 furnace increased to 4700 lb per sq ft of hearth area per day, which exceeds even the U.S. record of 4660 lb.

The coke consumption per ton of pig iron has also improved remarkably. The minimum is the monthly average of 1240 lb at Higashida No. 6 furnace, and the average of Japan as a whole is as follows:

	Lb per ton of iron
1950	1800
1951	1820
1952	1710
1953	1650
1954	1460
1955	1420

The quality of pig iron has also improved remarkably due to quality control. The average of Yawata Steel Works in 1954 was 0.76 per cent silicon, 0.026 per cent sulphur, and 0.17 per cent copper. In recent years the control of arsenic, tin and chromium became satisfactory.

The charged ore/coke (dry weight of iron ore excluding scrap and fluxes divided by dry weight of coke) ranges 2.2 to 2.4, and the CO_2 in the top gas is 14 to 15 per cent. The amount of gas produced per ton of pig iron is 81,000 cu ft, running about 90 Btu per cu ft. The amount of flue dust decreased to 30 lb per ton of pig iron. The chief reason for these improvements is the proper beneficiation of raw materials, the increased use of sintered ore, the improvement of coke quality, etc.

IMPROVEMENT IN EQUIPMENT

The hearth diameter of Kukioka No. 5 blast furnace (rated at 1100 tons per day) is 25 ft-3 in. The bosh is

10 ft-6 in. high, with a bosh angle of approximately 81 degrees. A freestanding blast furnace after the German design was set up near Tokyo in 1953 and another in Yawata. The number of tuyeres for 1100-ton furnace is 16, and 14 for 800-ton furnaces.

Brick for furnace lining has been imported from the United States since 1951, but it was decided that from 1956, only flint clay will be imported and the brick will be manufactured with the imported materials.

Since 1951, carbon blocks for lining have been used in Yawata Works and in 1955, Kukioka No. 1 furnace, with a carbon bosh, was blown in.

The use of carbon blocks in other plants in Japan is only about 50 tons around the bottom of the furnaces, but at Yawata it is as follows:

	Year blown in
Kukioka No. 3 furnace, 45 tons in bottom	1951
Kukioka No. 4 furnace, 280 tons up to cinder notch	1952
Kukioka No. 1 furnace, 450 tons up to bosh mantle	1955

Inwall cooling has gradually been emphasized. For example, 96 cooling plates in four rows have increased to 658 cooling plates in 21 rows.

Stoves have been improved and blast temperature has come to be automatically controlled. The combustion of gas is also regulated automatically, and of late, the use of automatic stove changing mechanism is increasing.

Steam turboblowers are mostly used, but in 1955 an auxiliary open cycle gas turbine of 400 kw was ordered by the writer's company and should be in operation by the end of 1956.

Temperature is measured at various points of the shaft and the bottom of the furnace. Automatic recorders have been applied to top gas composition as well as to the weight of charges. At Yawata, individual control of temperature and pressure of tuyeres is also possible by adding secondary cold air to the regular blast coming into the furnace through each tuyere.

RAW MATERIALS

The following are key items of import and production data:

	1953	1954
Pig iron production, tons	5,037,590	4,806,800
Iron ore, tons	8,117,070	7,498,960
Foreign ore, tons	4,848,940	3,776,150
Domestic ore, tons	588,770	391,030
Sinter, tons	2,479,360	3,331,780

If Japan could import as much as 5,500,000 tons of iron ore per year from abroad, the following would be the breakdown:

	District	Tons	Fe per cent
Philippines	Larap	1,320,000	54–55
	Samar	330,000	50–52
	Marinduque	275,000	56–58
	Others	55,000	
Malaya	Dungun	1,320,000	58
	Surimedan	220,000	60
	Others	110,000	
Hong Kong		110,000	58
India		880,000	65
Goa		550,000	60
U. S. A. and Vancouver, Canada		330,000	56
Total		5,500,000	

If we want to import more than 5,500,000 tons per year, imports from the United States must be higher, unless India could give us more than this schedule.

DOMESTIC SOURCE OF IRON ORE

In Japan there are no iron ore mines with deposits of more than 1,000,000 tons except a deposit at Kamaishi Ore mines, whose Fe base is 30 per cent. Most of the iron ore, however, is limonite with an Fe content of 45 to 55 per cent and sulphur content of about one per cent, which must be crushed down under $\frac{5}{8}$ in., to be used as a raw material of sinter. Iron sand is of course useful, but the amount available is only 30,000,000 tons, according to the latest investigation. It has usually four to five per cent of titanium, and sometimes contains more than eight per cent, and the molten pig will flow out of the cinder notch, when TiO_2 in the burden is over 25 lb per ton of pig iron. For this reason, the utilization of iron sand is limited to 10 to 20 per cent of the raw material of sinter. Pyrite cinder (the cinder from pyrite roaster in sulphuric acid plant) is one of the most important resources and forms 30 to 50 per cent of the raw materials of sinter. Although excess of copper content is its disadvantage, copper has been cut down to 0.25 per cent from 0.35 to 0.4 per cent by a leaching technique in sulphuric acid plants.

Now that the utilization of pyrrhotite, which exist mostly in western Japan, is proceeding in sulphuric acid plants the size of pyrite cinder is coming down under 150 mesh after the extraction of copper by flotation at the mine. Therefore, the increase of capacity of the pelletizing plant is under sincere consideration.

BENEFICIATION OF RAW MATERIALS

Since 1951, in most steel works in Japan, great progress has been made in crushing as well as in screening. Magnetite is crushed down under $1\frac{1}{2}$ in. Hematite and limonite are crushed under 2 in. Fine ore under $\frac{3}{8}$ in., (sometimes $\frac{1}{4}$ in.) is usually fed to sintering plants. Since 1954 the distribution of size of fine ore in Yawata Works has been as follows:

	Per cent
Under $\frac{3}{8}$ in.	25
$\frac{3}{8}$–2 in.	65
2–$2\frac{1}{2}$ in.	9
$2\frac{1}{2}$–4 in.	1

In Chiba Steel Works, the Robins bedding system was adopted, and pellets are produced at a rate of 300 tons per day, while at Yawata, a 40-ton pilot pellet plant was opened in 1955. In our Works, therefore, the fine ore up to 150 mesh is handled at sintering plants, and fine ore under 150 mesh goes to the pelletizing plant.

The screening of sintered products is carried out more efficiently by vibrating screens, and the product of

Dwight Lloyd sintering machines at Yawata is cooled by forced draft. Sintered ore forms the 40 per cent of the charge for blast furnace. In our works the standard rate of using open hearth slag is 300 lb per ton of pig iron.

It, together with limestone, is crushed under 3 in., and the slag under 5/8 in. is used for the raw material of sinter. The distribution of the size of open hearth slag and limestone is as follows:

	5/8 in.	5/8 in.–2 in.	2 in.–3 in.
Open hearth slag, per cent	9	69	22
Limestone, per cent	2	72	26

It is quite difficult to decide to what size the raw materials should be crushed in actual blast furnace operation. According to our experience at Yawata, the smaller the average size of iron ore becomes, the more CO_2 in top gas is generated, resulting in lower consumption of coke. But if the raw materials contain too much fine ore under 3/8 in., then efficiency is lost.

The raw materials to be used in Japan are manifold in kind and the variation of quality is also great, so the bedding system is applicable. Efforts are directed towards speedy sampling and analysis, and the systematic use of the raw materials.

It is also noteworthy that the study of cokemaking has developed much. As a result, the screen test index, which is the percentage of coke sieved by 5/8 in. and 2 in. screens respectively after 30 revolutions of the special testing drum in two minutes, and also the stability index of 1 in. by the ASTM tumbler test after 1400 revolutions, are maintained satisfactorily by blending about 30 per cent of American coal. The average size of coke is about 3 in., after the coke is screened over a 5/8 in. screen at the coke plant, almost no coke above 4 in. is to be found at the skip hoist in the blast furnace plant.

The minimizing of the variation of ash content and moisture in coke is urgent. With one-third of the material for coke being imported from U. S. A., the ash content is at present 12 per cent at Yawata and 10 per cent in other works in Japan. The moisture content in coke is 1 to 3 per cent and variation of ash content is 0.3 per cent.

HEAVY CHARGE

If the ash content of coke is lowered and the temperature of the blast is successfully raised, the coke ratio will be lowered. In actual operation, however, ore/-coke ratio must be boosted up. When easily reducible ore or fine ore is used, the coke ratio is to be lowered theoretically. But if "hanging" or slipping occurs when ore/coke ratio is increased, the coke ratio will not be improved actually.

When the strength of coke is greater, it will support the heavier charge. The harder the coke, the lower the reactivity and solution loss will be also. In this case, taking the combustion at the tuyeres into consideration, the size should be smaller according to the capacity of blast furnace.

It is generally believed that the sinter of lower content of FeO is more reducible; but the smaller amount of fine ore under 3/8 in. and the more uniform size of sinter are the most important conditions for a heavy furnace burden. In actual blast furnace practice, 100 per cent of pellets or sinter is seldom used, a large amount of fine ore being charged at the same time. It appeared from our experiment that gas flow through the furnace charge is better when hard sinter of higher content of FeO is blended, and any deficiency in heat quantity can be corrected by higher blast temperatures. Heavier burden is attainable when good sinter is blended and coke ratio will decrease. In short, the first requisite for lowering coke ratio is beneficiation of raw materials.

NOW IS THE TIME

to make your arrangements for the

1957 AISE SPRING CONFERENCE

April 29, 30, May 1

Netherland Hilton Hotel Cincinnati, Ohio

. . . . multi-row bearings were designed especially for roll neck mountings . . . . hydraulic mounting techniques help maintenance procedures . . . . performance is excellent . . . .

The MULTI-ROW Cylindrical Roller Bearing Roll

▲ IN any consideration of roll neck bearings, it must be noted that from earliest developments of rolling mills, the trend has been toward increased production with better quality through faster speeds, greater loads and closer accuracy. To keep pace, bearing companies have been continually improving existing roll neck bearing designs in an effort to achieve the best possible mounting for the demanding service of the most modern rolling mill practice.

Until shortly after World War II, anti-friction roll neck bearings themselves had not changed basically from the very first designs. To be sure, changes in boundary dimensions and internal manipulation of bearing geometry had permitted a better balanced design with increased bearing capacity. However, the overall mountings had serious limitations which became more and more evident as the demands for higher speeds and better quality grew more challenging. In 1947, the writer's company made a complete analysis of the situation. This detailed study proved the pressing need for a completely new roll neck bearing mounting which would handle, without limitation, modern rolling requirements. Consequently, work was begun on defining a specific design.

After considerable investigation, the multiple-row cylindrical construction was especially chosen for the basic radial bearing design because:

1. Pound for pound, the cylindrical gave the most capacity that could be put into a given space, permitting the best balance between roll neck diameter and bearing capacity for a particular roll size.
2. The capacity of the cylindrical was completely available for the high radial loads. Thrust loads could be handled with separate thrust bearings which could be picked for a specific function in a particular type mill.
3. The design permitted higher speeds than other roller bearing types.
4. The design could be readily adapted to hydraulic methods developed by the writer's company to achieve a tight neck fit with ease of mounting and removal.
5. Compensation for roll expansion could be taken through the rolling elements of the cylindrical bearing rather than sliding expansion through the screw load with resultant parasitic thrust loads placed on the already heavily loaded radial bearing.
6. The simple geometrical form readily lent itself to the most precise manufacturing methods, assuring accurate geometry with resultant close gage control of rolled product.
7. The completely separable construction made for much easier maintenance procedures.

Figure 1 shows a cut-away view of the resultant multiple-row construction which is now referred to as the multi-row cylindrical. Boundary dimensions (bore, outside diameter, width) were established based on an intensive study of both technical and commercial requirements. With the maximum diameter of the bearing dictated by minimum roll size, proper consideration was given to the popular roll diameters prior to determining a logical series of outside diameters that would adequately cover the entire range. Bearing section and width dimensions were then established to combine maximum capacity with maximum neck diameter. These carefully determined boundary dimensions were set for each bearing size in the series with due attention given to interchangeability with commonly used roll neck bearing types and sizes.

This multi-row bearing consists of four rows of modified cylindrical rollers having a roller length to diameter ratio held at an efficient 2 to 1. The two bronze cages have staggered pockets to distribute the load more evenly. Steel spacing rings and end plates effectively guide the rollers. The inner ring is a one-piece, through hardened, steel ring with a tapered bore.

Mechanically, the heart of the multi-row (of any roll neck bearing for that matter) is the inner ring which is the very keystone of accurate rolling. This is better visualized after reviewing the function of the three main bearing parts—outer ring, roller complement, and inner ring. The outer ring not only remains stationary with respect to the roll, but the load is concentrated in an arc of approximately 120 degrees on this ring. Thus, the accuracy, or concentricity, of the outer ring plays no particular part in accurate rolling. Moreover, the rollers of any bearing are sorted to very close diameter groupings, causing no special problem

By E. C. DENNE, JR., Manager, Rolling Mill Div.
SKF Industries, Inc., Philadelphia, Pa.

Neck Mounting

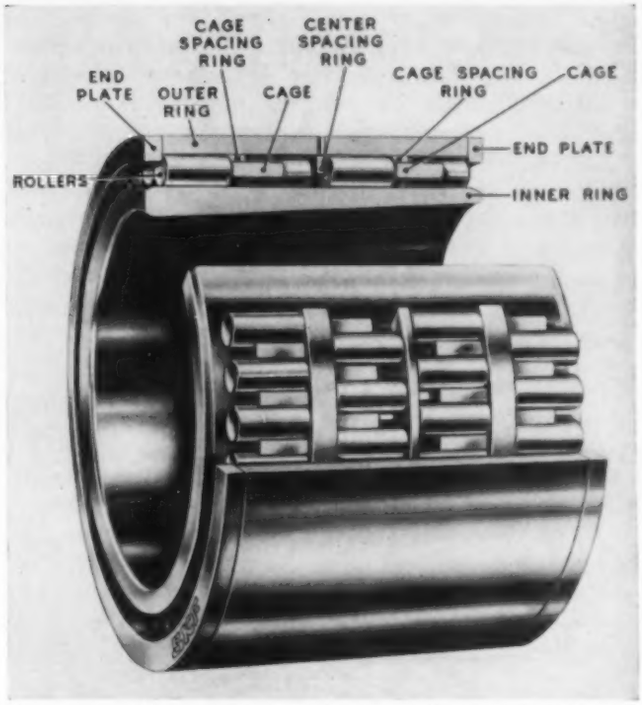


Figure 1 — The modern multi-row cylindrical roll neck bearing combines maximum capacity with maximum neck diameter.

from that standpoint. Therefore, more than any other part of the bearing, the inner ring is responsible for holding radial runout, thus runout of the mill rolls, to a minimum.

It is not difficult to see why the geometrically simple inner ring of the multi-row can be manufactured and mounted to produce the close running accuracy desired. After the end faces and outside diameter have been ground, the taper bore is centerless ground. This method results in the most accurate wall section possible throughout 360 degrees. This is a process where the product is uniformly and accurately produced in spite of the human element. Wall sections on the largest sizes show less than 0.0005 in. maximum variation as measured on a large group of big rings.

Accurate manufacture is only half the story; roll grinding and mounting is the other half. The inner rings on all sizes of these bearings are fully interchangeable. By using two spare inner rings on the roll necks to accommodate the steady rests for grinding the roll barrel, the result is the same as grinding the rolls on the complete bearing, eliminating radial runout between roll barrel and bearing. To complete the picture, the inner ring is mounted with a tight fit on the roll neck. The wide, one piece construction absolutely precludes creep, thus preventing the inaccuracies induced by a loose fit mounting. Accurate manufacture, precise roll grinding, and tight neck fit all permit the most accurate running of the mill.

HYDRAULIC MOUNTING AND REMOVAL

Settling on the basic design did not resolve the old problem of providing a tight neck fit which could be easily released. As early as 1931, Mr. A. G. Witting, then chief engineer, Illinois Steel Company, Gary, Indiana, in a discussion on a paper given before the ASME, expressed the right idea:

"There is another factor that may have to be considered because it may affect the rolling cost more than the expense for rolls and the bearings themselves. This is the ease with which a roll change can be made. In a mill where such changes occur frequently, perhaps several times a day, it is out of the question to have bearings that must be pressed off the rolls, whether it takes 80 or only 10 tons. It is also impractical and expensive to have a great number of spare sets all made up beforehand.

"To make the application of roller type bearings practical for an ordinary mill, even provided that the saving in power and longer life of the bearings compensate for the higher initial cost, it is necessary that the bearing is assembled in one-piece and the roll neck and the inner race of the bearing are made tapered so that the bearing can be quickly slipped on the roll neck and located in its proper position by a whack of a sledge hammer, and similarly loosened ready to be lifted by a hammer blow."

The first use of the tapered neck, tight fit roll neck mounting, left much to be desired, especially from the removal standpoint. The complete success of this type mounting waited upon the development of the hydraulic removal system. See "Improved Method for Mounting Bearings and Couplings" by A. S. Murray, 1948 Proceedings AISE. This method was developed by the writer's company to facilitate the application of roller bearings to marine shafts which must be coupled by rigid couplings. The oil injection method is based upon the fact that friction between contact surfaces of a pressure joint during fitting and dismantling can be almost entirely eliminated with the injection of oil under pressure into the fit surface.

Hydraulic mounting and removal may be used with either straight or taper bore bearings. However, additional advantages are achieved with the taper bore which includes:

1. Sharp and complete release of the tight fit when dismounting due to the axial component of the pressure at the fit surfaces.

2. Easier mounting with an annular hydraulic ram rather than the more difficult heating and shrinking on the roll neck.

3. Greatly improved roll neck fillet design. The resultant large neck permits using a relatively plain, but effective, fillet design that is easily manufactured.

Figure 2 shows how these simple hydraulic techniques are used in mounting. For bearings up to approximately 15-in. bore size, only the hydraulic mounting tool is needed to drive the bearing up the taper. The one piece inner ring construction permits oil injection at the fit surfaces to assist in floating the larger rings into position. This important feature permits using much lower hydraulic pressures and smaller rams. Floating into position also precludes axial scoring

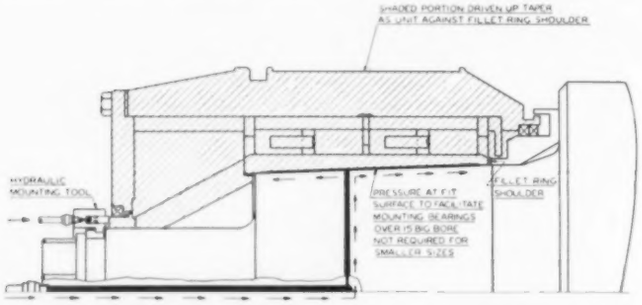

SHADED PORTION DRIVEN UP TAPER AS UNIT AGAINST FILLET RING SHOULDER
HYDRAULIC MOUNTING TOOL
PRESSURE AT FIT SURFACE TO FACILITATE MOUNTING BEARINGS OVER IS BIG BORE NOT REQUIRED FOR SMALLER SIZES
FILLET RING SHOULDER

Figure 2 — The mounting of a large multi-row with hydraulic ram is assisted by hydraulic pressure at fit surface.

of the roll necks which is a possibility when mounting large bearings without this feature.

To give a sense of proportion concerning the pressures involved, mounting a 24.6063-in. large bore bearing on a 1 to 12 taper requires approximately 4000 psi at the fit surface and 7000 psi maximum in the ram. Without hydraulic at the fit surface, and using the same ram, 10,000 psi in the ram will drive the bearing only 0.120-in. up the taper whereas with the aid of pressure in the bore, the bearing can be easily driven up the required 0.210 in.

Figure 3 illustrates the hydraulic removal technique which is as simple as backing off the locknut, hooking up the hydraulic pump, building a pressure of between 3,000 to 5,000 psi and then it is loose. The largest multi-rows have a 1:30 taper instead of 1:12, which requires approximately the same mounting and dismounting pressures for the large bearings as the small ones.

Compact, inexpensive, readily available, high volume, 10,000-psi hydraulic pumps already found in most mills prove adequate for mounting or dismounting the entire multi-row series (Figure 4). Where numerous roll changes are made at relatively close intervals, such as in rod mills, motor-powered pumps with 10,000-psi capacity prove to be valuable time savers. In an emergency, a standard, hand operated grease gun can be used for dismounting.

THRUST BEARINGS

Since the design of this type cylindrical bearing does not permit carrying thrust, separate bearings must be employed to handle these indeterminate loads. This, in itself, has its good points since the thrust bearings may be chosen to perform an exact function for any particular type mill, while the already heavily loaded radial bearing is relieved of this additional load—a load which when resolved into its radial component is many times the thrust load. In addition, the expense involved in replacing a thrust bearing, because of a high thrust condition, is less than replacing a combination roll neck mounting.

Design work on anti-friction back-up roll thrust bearings used in connection with flood lubricated bearings, was begun in the early thirties. Initial installations proved to be far superior to the old plain thrust bearing. Over the years, as mills became older resulting in crossed rolls consistent with normal wear of parts, greatly increased thrust loads resulted in revamping of the original anti-friction thrust bearing designs. The basic

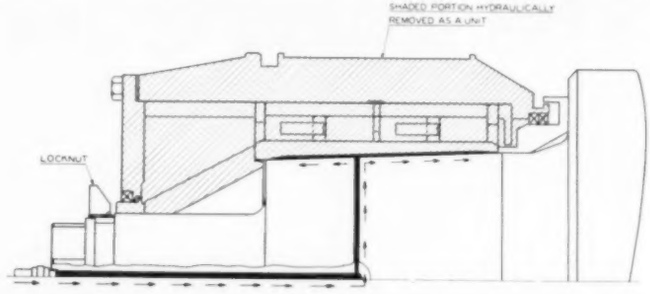


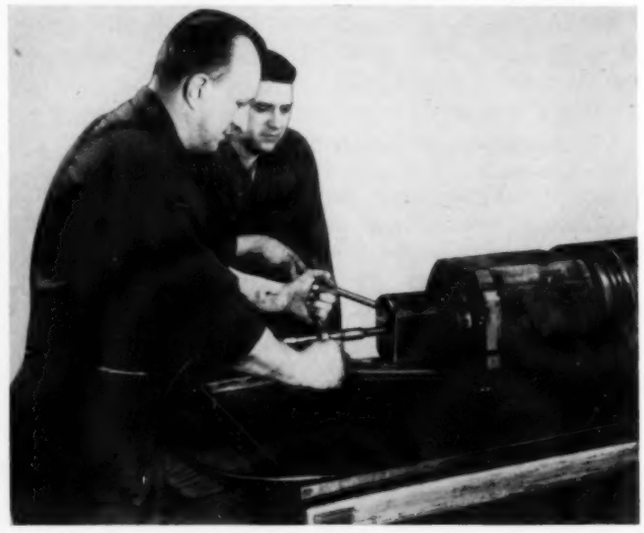
Figure 3 — Chuck assembly removal from roll neck by hydraulic methods is simple.

thrust bearing housings were seldom changed, which meant that new designs had to provide maximum capacity in a predetermined space.

One of the most recent thrust bearing designs for larger mills (Figure 5) utilizes the new improved "C" type spherical bearing with rollers on a steeper angle. This bearing was designed to fit an exact space with an eye to incorporating the most capacity that could be put into that space. Before putting this new design into production, prototypes of this bearing were tested in mills to establish the actual performance of such a design. Even after two and one-half years of continuous service these original bearings look as good as new and show no signs of distress. This style bearing has been so designed that it can be used in existing plain bearing equipped mills without any changes or in newer mills which incorporate spring loaded mountings.

In mills rolling sections, such as rod and bar mills,

Figure 4 — Hydraulic removal of rod mill roll neck bearing assembly is done with compact 10,000-psi pump.



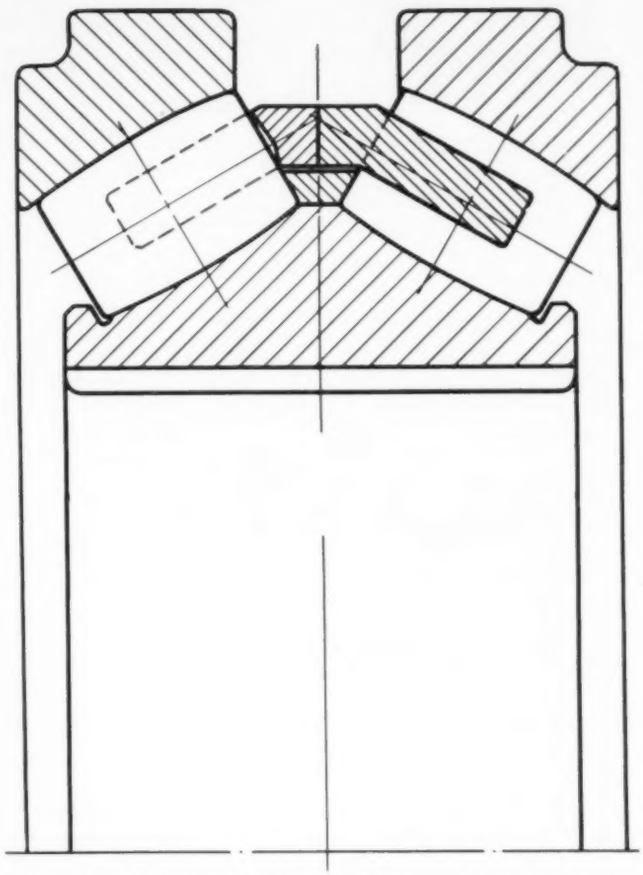


Figure 5 — Spherical back-up roll thrust bearing have a steep angle.

preloaded angular contact ball bearings may be used in the thrust locations, resulting in exact axial stabilization of rolls even at high speeds. Combination radial and thrust roll neck bearings (such as twin spherical or four-row tapered roller bearings) when internally tightened to give close axial stabilization of the roll, are too tight at high speeds, resulting in hot running bearings. Conversely, if the internal clearance is loose enough to permit high speeds, axial control cannot be satisfactorily maintained. On the other hand, the multi-row mounting permits using the correct internal fit in the radial bearing to handle the high speeds and a tight fit for the thrust unit to give close axial control of the roll.

Work with preloaded angular contact bearings for mills rolling shapes began in 1941 when the Columbia Steel Co. Pittsburgh, Calif., purchased a 21-stand rod mill which incorporated preloaded angular contact bearings in the thrust location (Figure 6) and water bearings to handle the radial loads. Even though the mounting proved far superior to plain thrust units, the true worth could not be realized since wear in the plain radial bearing with attendant vertical roll adjustment resulted in a difficult problem. It was necessary to design an axial locking and adjusting device which would keep the rigid ball bearing mounting properly alined and at the same time, hold its separate housing rigid axially. While some designs have, through constant vigilance of trained operators, performed well, the obvious solution was to incorporate these thrust units and the radial bearing in a common housing, which has been done with flood lubricated as well as cylindrical roll neck mountings.

MOUNTING CONSIDERATIONS

Having determined the basic radial and thrust bearing designs, further effort was directed toward combining these two bearings into the most effective mounting. This required study of all types of rolling processes with an eye to making a logical construction for each type.

For this purpose, mills could be conveniently classified into two general catagories: (1) those requiring precise axial stabilization and adjustment of the rolls, and (2) those where such accurate stabilization was not necessary. Preloaded angular contact or spherical bearings mounted in a common chuck adequately handled

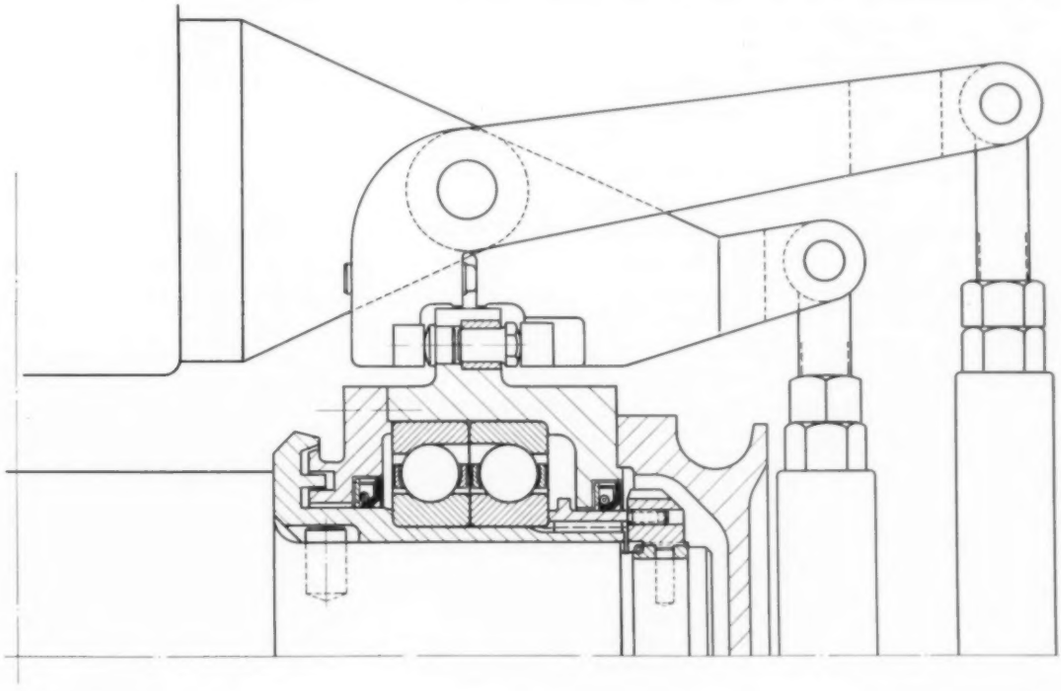


Figure 6 — Angular contact thrust bearing unit is used for close axial stabilization of plain radial bearing equipped rod mill rolls.

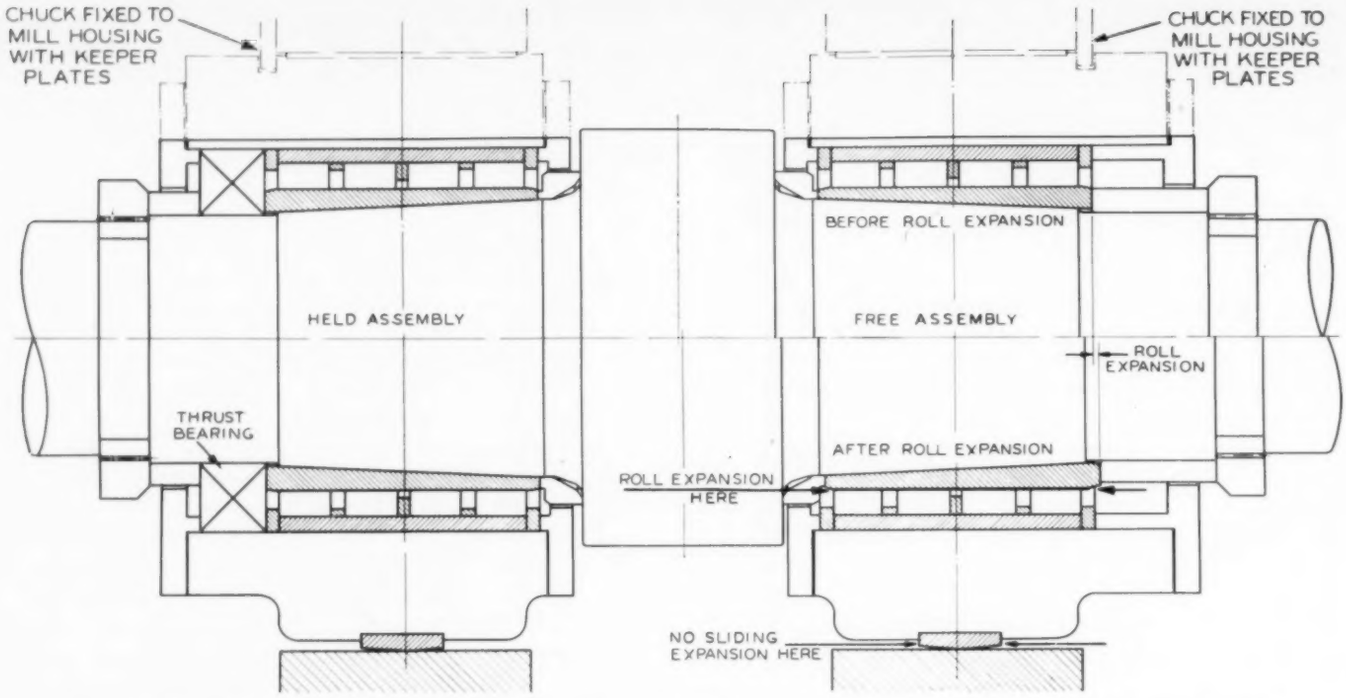


Figure 7 — Mill expansion analysis shows rolling expansion between inner ring and rollers of multi-row bearing.

these two cases respectively. However, mounting these assemblies with respect to the roll and the mill required further consideration.

Figure 7 shows a roll expansion analysis of the multi-row. To better visualize what occurs, it must be understood that the inner ring of the multi-row is completely separable from the rest of the bearing. Considering the inner ring as part of the mill roll, and that the chucks are not fixed with respect to the mill post or to each other, it is seen that the free chuck assembly can be moved back and forth between the locknut and the edge of the roll barrel, having more or less complete axial freedom with respect to the roll. Should a thrust bearing be introduced as shown in the held chuck, this chuck would then become axially fixed with respect to the roll.

For those mills where axial control of the roll is of no importance (within limits), this feature is of special significance. The typical arrangement shown in Figure 7, wherein only one thrust bearing is used per roll, illustrates how axial heat expansion of the roll is permitted to occur between the roller complement and the outside diameter of the inner race in the free chuck assembly. This is of particular importance when rolling off the "spring of the mill" (rolls faced and mill preloaded), since the high, additional, parasitic thrust loads which develop from trying to expand by sliding through the screw loads are eliminated.

Figure 8 shows the more common methods for locking chuck assemblies with respect to the mill posts. For mills requiring close axial adjustment, thrust bearings are used in both chucks (Figure 8). The chuck containing the preloaded angular contact bearings (B) is fixed to the mill post by some adjusting device. Chuck (A) is not fixed to the mill post since its position is maintained with respect to the roll neck by a separate thrust bearing.

For mills rolling flat stock, a system of keeper plates, with or without spreader bars, may be used (Figures 9 and 10). Chucks (B) contain thrust bearings; chucks (A) are designed without any thrust unit similar to the free assembly, Figure 7. With this system, both chucks can be fixed to the mill posts with keeper plates (Figure

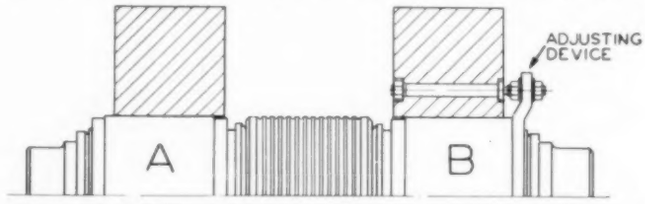


Figure 8 — Mill post locking arrangement for multi-row bearing has close axial adjustment.

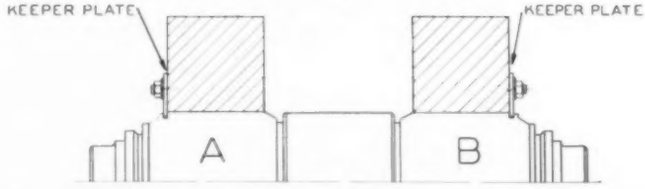
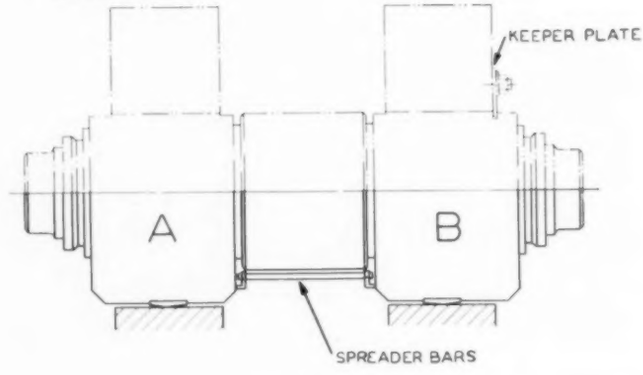


Figure 9—Mill post locking arrangement for bearing has keeper plate.

Figure 10 — Mill post locking arrangement for bearing has spreader bars.



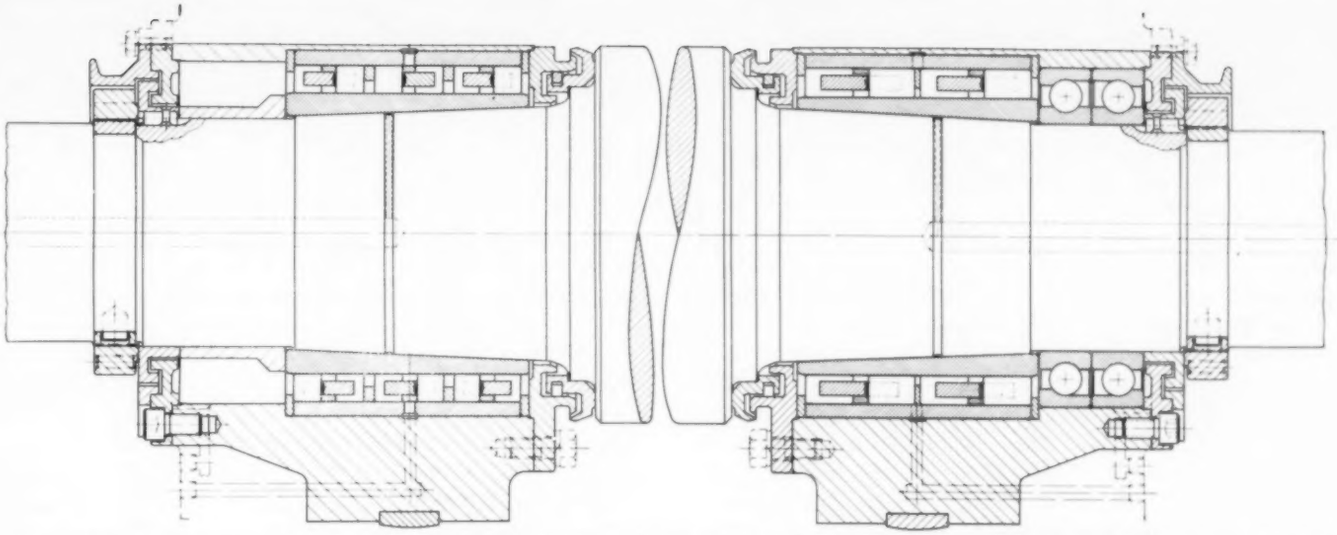


Figure 11 — Changeover of multi-row bearings to 3¾ in. and 10½ in. x 7¾ in., four-high, cold mill. Original six-row bearing is shown in free drive end chuck and later interchangeable higher capacity four row design is shown in held chuck.

9) or chuck (B) fixed to the mill post and chuck (A) positioned by spreader bars, (Figure 10). Either of these systems permits rolling and roll expansion as previously described.

PERFORMANCE

Having defined the desirable features of a new roll neck mounting and projected a course of development, it remained to make some applications and actually establish the capabilities of such mountings.

In 1947, progress was begun on two significant applications. A small 3¾ in. and 10½ in. x 7¾ in. four-high cold mill located in the Philadelphia area was equipped with different type anti-friction bearings applied with a loose fit on the roll necks. Because of the relatively severe rolling schedule, the application was not completely satisfactory. Accordingly, the design was changed to a multi-row mounting (Figure 11) which incorporated six rows of rollers with length to diameter ratio one to one, which was later superseded with an interchangeable four-row design having a roller length twice the diameter, resulting in a more efficient, higher capacity mounting. The successful performance of this initial test proved the soundness of such a design, giving added confidence to further work in this direction.

At about the same time, work was started on developing a multi-row mounting to be incorporated in two new stands (20 and 21) of two 19-stand, 3-strand rod mills (Figure 12). It was planned to keep the speed of No. 19 stand the same and increase the output speed in the new stands 20 and 21 to 1230 and 1330 rpm respectively. As the rolls for stands 20 and 21 would be used for stands 18 and 19, these stands were also changed over to this same mounting.

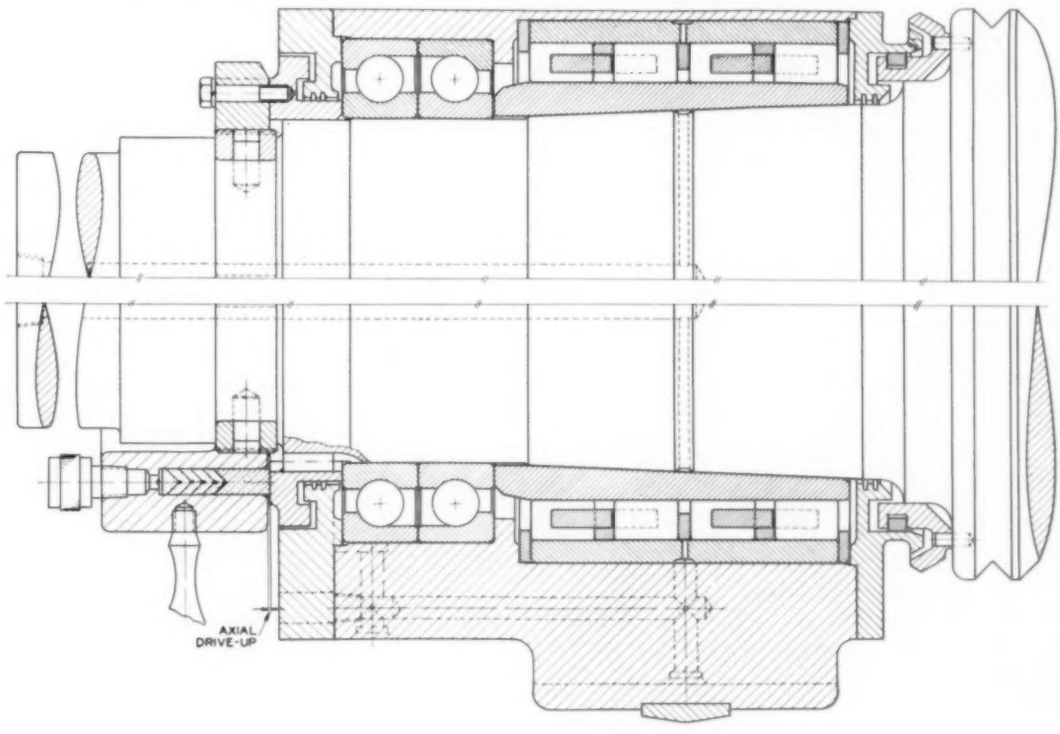


Figure 12 — Rod mill mounting shows first annular hydraulic ram used to greatly simplify driving taper bore bearing on roll neck.

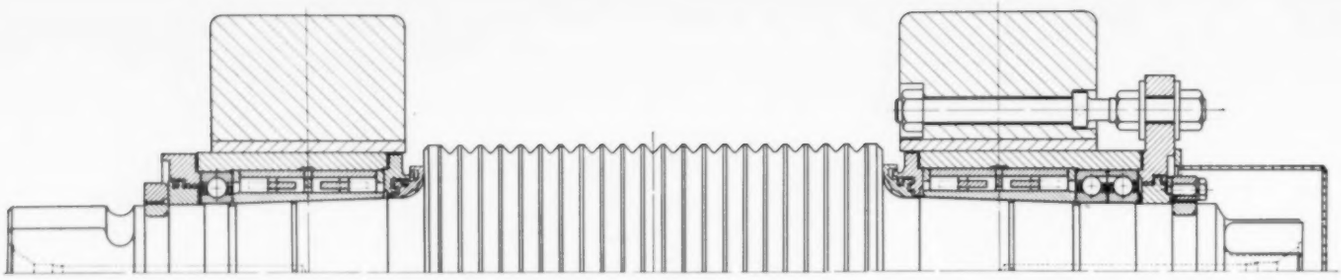


Figure 13 — A 10-in. high speed rod mill mounting shows multi-row in radial position and angular contact ball bearings for close axial adjustment of rolls.

The mill had also experienced considerable roll neck breakage on No. 10 stand, moreover, this stand had not been as flexible as desired. First, the chuck section, determined by the bearing outside diameter, combined with another undesirable design feature, prevented using the minimum roll for which the speed range of the drive had been set up. The length of the bearing mounting plus the axial adjustment feature was such that roll deflection was of an appreciable magnitude at the end of the adjustment device. Accordingly, stands No. 10 and No. 12 were changed over in both mills, the latter because the rolls for No. 10 came from No. 12 stand.

The two mills started rolling in the early part of 1948, having six stands in each equipped with the multi-row arrangement, resulting in a radically simplified mounting and dismounting procedure; positive axial adjustment not influenced by internal looseness of the radial bearings; relatively inexpensive and satisfactory grease lubrication at high speeds; larger roll necks (from 6 in. in the old mounting to 6 15/16 in. in the multi-row) with improved fillet design which substantially reduced roll neck breakage; more capacity in less space, giving the flexibility of smaller minimum roll size (from 10¾ to 10⅝ in.); and the virtual elimination of the costly shutdown of mills due to bearing failures in high speed stands.

In 1950, one large steel company contemplated building a 3-strand mill of the most modern design. Impressed by the multi-row cylindrical and the reports of the success of this bearing, it was decided to change over one stand in an older mill to verify the performance before building a completely new rod mill dependent for its success on an entirely new mounting. Satisfied that the mounting would perform satisfactorily, a 3-strand, 22-stand rod mill was purchased with eight 12-in. intermediate stands and six 10-in. finishing stands equipped with the multi-row mounting (Figure 13). Subsequently, six more high speed rod mills have been equipped with this design. Records show that scrap loss because of bad section is less than ½ of 1 per cent. In large part, this record can be attributed to the roll neck bearings. It is understood that roll neck bearing costs (including maintenance, failures, etc.,) in the fourth year of rolling were approximately $0.11 per ton of rolled product.

Based on the performance records obtained on rod mills, in 1952, larger multi-rows were installed on mills rolling flat stock. Four 6 in. and 28 in. x 30-in. back-up roll—driven four-high cold reversing brass mills were built (Figure 14). The back-up rolls were equipped with multi-rows (17.8347 in. bore, 25.5906 in. outside diameter, 19.2126 in. width) and work rolls with needle roller bushings. The back-up roll bearings were the largest multi-rows that had been installed up to that time. Remarkably enough, the big jump from the smaller rod mill bearings to the larger sizes did not carry with it the attendant operating difficulties that are usually expected on an initial installation where many of the problems must be figured theoretically. The separating loads in these mills are on the order of 200,000 lb per

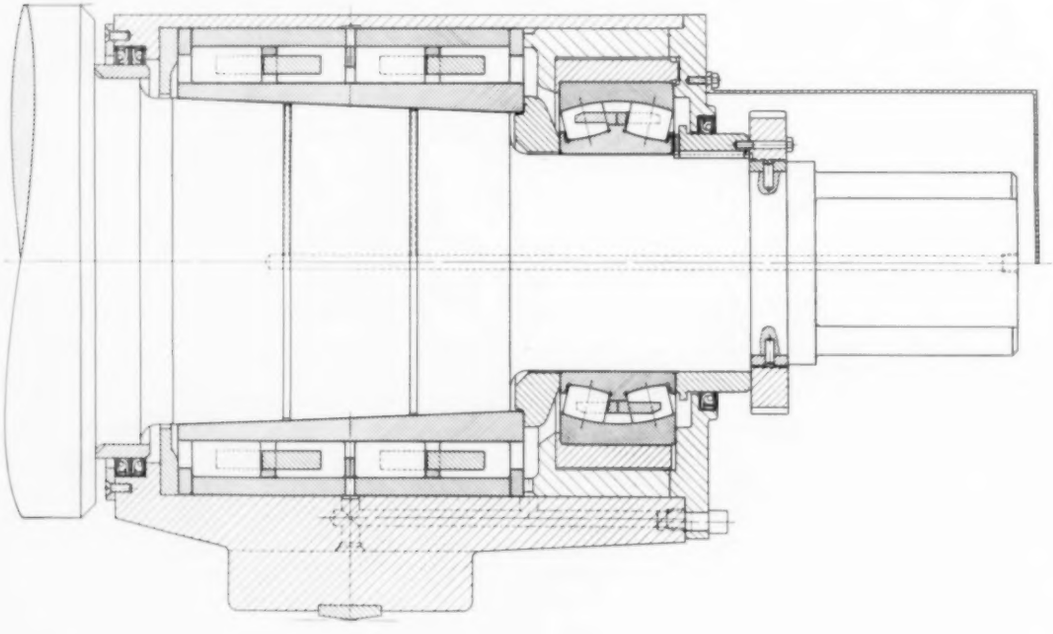


Figure 14 — Multi - row mounting is on 6 in. and 28 in. x 30 in., four-high back-up roll driven cold mill.

screw. The mills are used to reduce hard copper from 0.030 to 0.015 in. and from 0.025 to 0.010 in. Both copper and brass are rolled to gages in 25-in. widths as light as 0.004 in. Brass is reduced 50 to 60 per cent between anneals.

Multi-rows having a 13.1759-in. bore, 18.5039 in. outside diameter and 13.7795 in. width have been installed on two 20-in. x 22-in. two-high single stand, cold mills rolling aluminum and copper. Aluminum as received has a gage variation of as much as 0.020 in. in 3600-lb coils. After reducing from 0.102 to 0.014 in. in six passes with one intermediate anneal, final gage is well within the required 0.0005-in. tolerance from end to end and side to side.

In one instance on one of the first multi-row equipped strip mills (bearing 10.1457 in. bore, 14.1732 in. outside diameter, 10.5512 in. width) running at speeds up to 1000 fpm, it was noted that the inner ring of the multi-row had turned on the neck with resultant severe scoring of the neck and bearing bore. The trouble was traced to improper driveup of the bearing on the neck. The high points of the score marks on the tapered necks were dressed down with a file and the bearing bores touched up with a hand grinder. Even with the score marks present, proper driveup resulted in absolutely no turning of the inner rings on the roll necks—further proof of the advantage of the one piece inner ring design.

This case history clearly illustrates that when dealing with the human element, there is always a chance for error. To reduce these chances to a minimum, new multi-row mountings have been designed to have the inner ring driven to a stop. Thus, instead of the maintenance man measuring the axial driveup, his only concern is driving the bearing until a sharp rise in pressure is noted on the hydraulic pump used for mounting.

It must be pointed out that the tapered bore must be timed with the end face of the inner ring to make driving against a stop a fully interchangeable process. All of the standard series of multi-rows incorporate this refinement. Even though not required from an operating standpoint, this feature could be incorporated in earlier designs for added convenience.

In the spring of 1952, a 6 in. and 24 in. x 18 in. experimental four-high cold mill was put into operation. Multi-rows with boundary dimensions of 15.3083-in. bore, 20.4724 in. outside diameter and 14.1732 in. width were used on the back-up rolls and needle roller bushings on the work rolls. The mill was designed for very high separating loads and included driving both backup and work rolls simultaneously at strip speeds up to 40 fpm for the special rolling process involved. Loads up to 900,000 lb per bearing (1,800,000 lb separating load) have been recorded on accurately calibrated load cells. Even though the backup roll multi-rows have performed most satisfactorily under these high load, low speed conditions, difficulties were experienced with the rigid needle roller bushings used on the work rolls. This unsatisfactory work roll bearing performance was attributed to deflection of the work rolls (as much as 0.005 in. at the center of the roll) and high radial loads resulting from the extreme separating loads, strip tension, and the four roll drive.

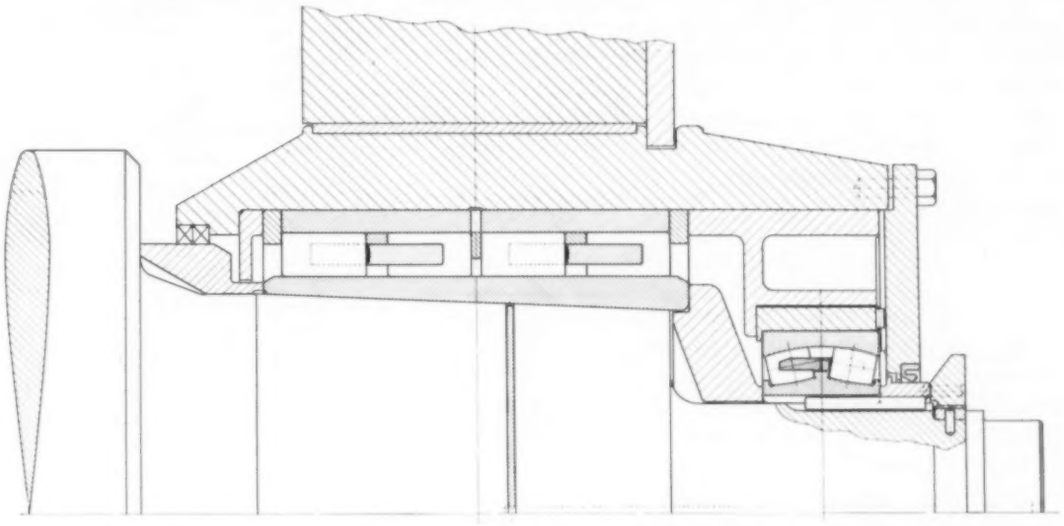


Figure 15—Multi - row mounting is on 18½ in. and 39 in. x 40 in., four-high hot mill.

The problem of incorporating adequate bearings on relatively slender, small diameter work rolls on a mill with high separating loads is one that has not received too much specialized attention. At times, it is not only difficult, but next to impossible to make a satisfactory compromise between roll neck diameter (to handle driving torque), minimum roll diameter (sized for rolling requirements), and bearing capacity. Also, with the high deflections involved, the method of mounting has much to do with how much of the bearing capacity may be realized. Suffice it to say that from the number of inquiries received on this problem, it is one that is yet to be solved with complete satisfaction.

Early in 1954, one 18½ in. and 39 in. x 40 in. four-high hot mill (Figure 15) and two 24 in. x 40 in. two-high cold mills were installed with multi-rows. The mills were set up in more or less tandem arrangement to form part of a semi-automatic processing line rolling a special aluminum product. Because of the special rolling process, an initial requirement on these mills meant holding radial runout of the roll neck bearings within 0.001 in. The bearings were manufactured according to normal centerless grinding methods which resulted in less than 0.0005 in. inner ring wall variation. The mills began operation in early 1955. It has now been determined that gage is being held so closely in the hot mill and first cold stand, that the second cold mill is not needed for the process involved. Among other things, these results certainly point out the benefits that can be

obtained in being able to hold close gage on hot rolled product.

CHANGEOVER POSSIBILITIES

Changeovers have been made on existing roll neck mountings to the multi-row because of numerous reasons, such as:

1. A desire to use a more severe rolling schedule with heavier loads or to achieve more satisfactory bearing life under present loads.
2. An intention to roll at higher speeds.
3. A desire to reduce excessive roll neck bearing maintenance costs.
4. A need for greater accuracy, uniformity and quality of rolled product and a need for a more rigid mill with reduced roll neck breakage.

The small section height and high capacity of the multi-row favors a changeover design. Generally, modification to existing rolls and chucks is all that is required. In those cases where new chucks or new rolls (or both) are necessary, the additional expense has discouraged many mills from making the change. However, in all instances where such a complete modernizing treatment has been found necessary and subsequently made, the improved performance has justified the additional cost.

As a case in point, the heaviest loaded stand of a 12½ in. x 16-in. two-high, 4-stand tandem cold mill rolling steel strip was changed over from a different type roller bearing to the multi-row. Very short bearing life with resultant high maintenance and bearing costs per ton of rolled product brought about this change. Separating loads in the mill ranged to 300,000 lb maximum at strip speeds of 131, 196, 262 and 393 fpm in the four stands respectively. This change not only required new rolls and chucks, but changes to the mill windows as well. Bearing life is now measured in terms of years rather than weeks, and bearing maintenance costs have been materially reduced. On the basis of this improved performance in the heaviest loaded stand, the other three stands have been changed over.

In another instance, the first and very heavily loaded stand (16 in. x 24 in. two-high) of a 3-stand tandem cold mill was experiencing an epidemic of roll neck breakage and bearing failures. The bearings were changed from the roller type to plain bearings which reduced neck breakage. However, the power load increased to the point where it became necessary to reinstall the roller bearings along with the attendant difficulties. Even though new rolls, chucks and other modifications would be required, the situation demanded a change. The change was made using the multi-row. This new mounting has now been in operation for approximately four months. No roll necks have been broken and the bearings show no signs of distress indicating another tough roll neck problem satisfactorily solved with the multi-row.

Numerous other such changes could be cited with equally positive results. It is not the writer's purpose to prove the performance record of the multi-row as such. Rather, it is the intention to point out that there is a roll neck bearing arrangement available that enables modernizing older mills; an arrangement available at a moderate cost generally paid for in a short time because of savings brought about by greatly improved performance.

ALLIED APPLICATIONS

The two main reasons for using anti-friction bearings instead of plain bearings in straightening machines are: reduced power consumption (as much as 50 per cent), and a more accurate adjustment of the rolls without bearing wear. Because of the high load carrying capacity within a small space, the multi-row is particularly suited for those types of straighteners where overhung rolls are used. One 18 in. x 30 in., 9-roll channel and rail straightener has been equipped with multi-rows on both ends of the rolls. Straightening can be done either on overhung rolls or between the bearing mountings. Products include 16 to 25-lb rails, angles up to 6 x 6 x ½ in., and special channel sections, which are straightened on the overhung rolls and 30 to 60-lb rails and special heavy channel sections straightened on the main roll body at 100 to 125 fpm.

Again, the high load carrying capacity within a small space has permitted utilizing the multi-row on the cone roll shaft of an 18-in. pitch diameter rotary piercer. Previously used plain bearings showed lives of from six to eight weeks. One of the two original multi-rows has failed after seventeen months. The other original bearing was inspected at that time and found satisfactory for further use.

APPLICATIONS IN PROGRESS

The multi-row has now been specified on many new high speed aluminum cold mills presently in various stages of design, manufacture and erection. With features making it peculiarly suited to handle the high

TABLE I

Mill Size, in. and Type	Bearing Size, in.			Mill Duty Rating Per Bearing 33⅓ rpm, 500-hrs
	Bore	Outside diam	Width	
12 & 40 x 60-4-High cold	24.61	34.25	25.20	4,340,000
9½ & 34 x 60-4-High foil	20.87	29.13	21.26	3,100,000
12 & 36 x 62-4-High jobbing	22.05	30.71	22.83	3,500,000
8½ & 24 x 24-4-High cold	15.31	20.47	14.17	1,360,000
20½ & 49 x 72-4-High cold 2-Stand tandem	31.50	44.09	31.49	6,950,000
20½ & 49 x 72-4-High cold	31.50	44.09	31.49	6,950,000
4 & 14 x 20-4-High cold	8.66	12.20	9.06	550,000
30 & 55 x 96-4-High hot	33.07	46.46	33.46	7,840,000
20 & 53 x 72-4-High cold 2-Stand tandem	33.07	46.46	33.46	7,840,000
20 & 52 x 72-4-High cold	33.07	4.646	33.46	7,840,000

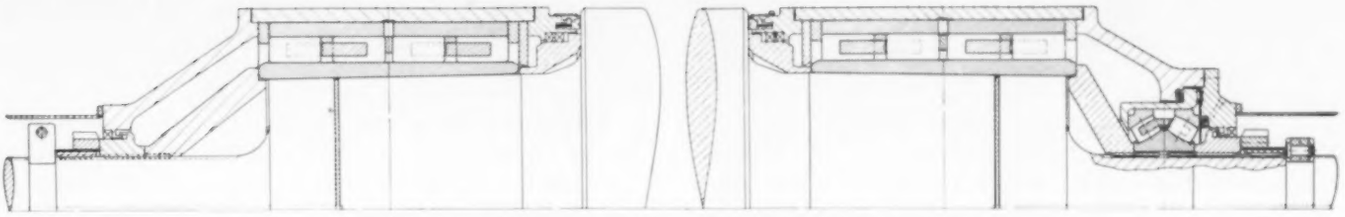


Figure 16 — Mounting on large four-high mill is typical.

speed, high load, light and foil gage rolling of aluminum, and with an established performance record on similar but slower speed mills, there is every confidence that the multi-row will more than adequately handle these rolling requirements. Table I outlines the size and bearing data on many of these new mills.

Figure 16, illustrates, in general, the back-up roll bearing mountings for these mills. But for a few changes because of size, the general design is much the same as the first mountings applied in 1947. For convenience, the inner rings are driven against a roll neck fillet ring. Three rows of lubrication inlet holes have been designed into the larger outer rings. Full threaded rings instead of split rings have been used to permit easier lockup of the bearing assembly on the roll neck and easier application of the mounting tool.

USE IN OTHER COUNTRIES

Independently of the work done in the United States, a notable number of German mills have been equipped with large cylindrical roller bearings. Sweden and England have also done work in this direction. After World War II, the great demands for larger production placed on the German steel industry as a result of reconstruction, resulted in further demands for more modern and effective rolling mills as well as modernizing existing equipment. In many instances, the increased loads and speeds necessitated new anti-friction bearing designs. Large cylindrical bearings similar to the ones used in the United States were chosen as the most acceptable basic design. All types of mills rolling ferrous and non-ferrous metals, ranging in size to 54 in. diameter back-up rolls have been so equipped. Bearing proposals have been made for mills having 65-in. diameter back-up rolls.

LUBRICATION AND MAINTENANCE

Of all the roller bearing types, the cylindrical has the lowest coefficient of friction, thus making it the easiest to lubricate. Even at high speeds, grease gives satisfactory lubrication in the majority of installations.

Multi-row cylindrical bearings used on rod mills are successfully lubricated with an automatic greasing system at speeds in excess of 1800 rpm. This represents a so-called dn (bore in millimeters x speed in rpm used as a rule of thumb for anti-friction bearing speed) value of 300,000. As with most hot mill applications of this type, the grease serves to increase the effectiveness of the bearing seals.

For many types of cold rolling, the trend is towards oil lubrication for two reasons:

1. To prevent mixing bearing lubricant with rolling coolant, causing off-quality product.
2. Easier bearing inspection—no degreasing necessary.

Because of the ease of lubrication of the multi-row, prime consideration need only be given to how the bearing lubricant can increase the overall effectiveness of the mill.

Most of the roll neck illustrations presented herewith show the method for introducing grease or oil through a groove in the chuck to holes located in the center of the outer ring of the multi-row. By bringing the lubricant in at this point, the new lubricant immediately gets to the point of action, while, at the same time, causing a continual flushing out of the old lubricant. Whether grease or oil be used, an extra fitting is applied in the outboard end cover to permit positive lubrication to the thrust bearing.

For maintenance purposes, the completely separable construction of the multi-row permits thorough inspection of all parts. The inner ring can be lifted out by hand for smaller bearings or with a suitable piece of hardwood wedged in the taper bore for the larger bearings; the roller complement can be removed from the outer race intact with a simple handling tool (Figure 17). If required, the rollers can be completely separated and inspected individually without cutting or burning of parts. Since proper clearances have been built into the bearings, no attention need be paid to adjustment for reassembly. The interchangeability of inner rings and other parts permits rebuilding a bearing without returning it to the manufacturer should such an emergency occur.

SUMMARY

The cylindrical was used on the first anti-friction roll neck bearing mountings; was nurtured through the

Figure 17 — The completely separable construction of the multi-row greatly simplifies inspection.

years by improvements in design, manufacture and mounting techniques; now in the modern multi-row form it has gained general acceptance based on a most satisfactory performance record. In brief the bearing:

1. Was specifically designed for roll neck mountings.
2. Incorporates all features necessary to handle high loads and speeds with the most precise running accuracy.
3. Has been proven under most all types of rolling conditions.
4. Lends itself to easy maintenance procedures.
5. Has never been replaced by any other type bearing in any of the hundreds of mountings made to date.

Even though this record speaks for itself, work has continued in an effort to further improve the overall effectiveness of the multi-row mounting in anticipation of tomorrow's requirements.

DISCUSSION

PRESENTED BY

C. E. PRITCHARD, Superintendent of Mills, Alan Wood Steel Co., Conshohocken, Pa.

E. C. DENNE, Jr., Manager, Rolling Mill Div., SKF Industries, Inc., Philadelphia, Pa.

M. D. STONE, Manager, Research and Development, United Engineering and Foundry Co., Pittsburgh, Pa.

C. E. Pritchard: Present day mill practices have definitely presented additional requirements in increased bearing loads and higher speeds. This, obviously, necessitated consideration being given to the development of greater capacity bearings of which the multi-row or 4-row type bearing seems to be the most commonly accepted in design.

Such installations as higher speed temper pass mills, cold tandem reduction mills and so forth have also placed a premium on the bearing mountings in that excess creepage of loose fit races has resulted in extreme roll neck scuffing and its attendant higher roll and bearing costs, plus untimely mill operating delays.

Although many devious methods were developed to minimize the problem of roll neck scuffing, none was found to be of any major importance in meeting this proverbial problem of scuffed necks until the advent of the so-called tapered bore bearing and hydraulic mounting procedure.

These multi-row-tapered bore bearings have provided maximum capacity with longer roll neck life and better maintenance of mill settings. Of significance is the fact that despite the interference fit employed, it is possible to install and remove the bearing chock assemblies as a complete unit with comparative ease and minimum lost time.

The ability to obtain a lower roll neck stress and deflection factor with this type of design thereby explains why a general acceptance of the same has been adopted by both the bearing manufacturer and the mill operator.

Interchangeability of the bearing components has been given considerable attention by the bearing manufacturer and will undoubtedly prove to be of material benefit to the flexibility of mill operations and, of course, basic economics. Control of radial run-out between the roll barrel and bearing during grinding on spare inner rings should prove to be of material benefit in evaluation of roll and bearing costs.

Experience has indicated that no one bearing design can be offered as a panacea for all ills, but rather that the specific bearing service requirements encountered will dictate the final selection due to the many ramifications involved.

This paper has provoked several questions and I will offer them as follows. Some of them are related.

1. What is the line of demarcation in mill speed, in fpm, where it is conceded advantageous to convert from grease to oil lubrication of roll neck bearings on cold reducing mills?

2. Are hydraulic mounting and demounting of tandem mill work roll bearings recommended?

3. What comparisons might be drawn between the service life record of the straight neck mounted bearings where rotation of the outer race has been recommended practice in the past, during maintenance inspection periods, with those of the tapered bore interference fit inner race type of today?

4. Has any rule of thumb been developed to cover the rolling mill service life expectancy of the multi-row type bearing as compared with the conventional design?

5. Is it recommended practice to mount bearing and chock assemblies on the work rolls out on the mill floor or do you recommend that same be removed to a remote point for this type of service?

E. C. Denne, Jr.: From the standpoint of speed, the line of demarcation concerning whether oil or grease lubrication be used, depends on a number of things. With the multi-row bearing, type of lubrication generally is dependent upon how the lubricant can increase the effectiveness of the mill. For instance, for rod mill applications, grease increases the effectiveness of the seals. Even at rod mill speeds of 6400 fpm, grease is used with satisfactory results when added in rather small quantities at frequent intervals. When it comes to the point where you have to add too much grease too often, the only recourse is to change to oil lubrication. At the present writing, mill speeds have not reached the point where oil lubrication is mandatory from a bearing standpoint.

The question of hydraulic mounting and dismounting on tandem mill work roll bearings is one that has not been faced to any extent to my knowledge. It is my considered opinion that with the continual trend to faster speeds, a radical departure from the standard loose neckfit work roll bearing mounting, now more or less standard in the United States, will have to be made. Perhaps we have reached that stage of evolution on some of the more modern high speed mills, but as yet either have not recognized it as a problem or have refused to argue with the success achieved with the standard antifriction work roll bearing designs commonly used throughout the industry today.

To date, the multi-row bearing has not been used on work roll applications. When the time comes where speed dictates a tight neck fit, and I am certain we are beginning that period of progress, there is no question but what we will recommend the multi-row mounting with hydraulic removal. The first design we anticipate

putting on high speed work rolls will have a straight bore, one piece inner ring, and the roll neck will be drilled for hydraulic removal. In the normal course of changing rolls, the inner would stay with the roll neck throughout the life of the roll—the chuck assembly would be easily slipped on or off of this inner ring. When it would become necessary to remove the inner for any reason, straight bore hydraulic removal would make this an easy process.

However, there is one thing to remember about straight bore hydraulic removal—you do not get complete and sharp release of the inner ring from the roll neck as you do with the taper bore mounting because there is no component of the hydraulic pressure in an axial direction. With the use of a suitable puller, you can use hydraulic pressure in the bore, and it makes it very easy to remove that inner ring quickly even though it is a straight bore application.

Referring to the third question, are you referring to expected increased life through the periodic turning of the outer ring with reference to a straight bore loose fit or tapered bore tight fit mounting?

C. E. Pritchard: With all preventive maintenance programs that I have been associated with personally the recommendation has been made that at regular intervals of inspection you should rotate the outer race and it has apparently paid off. What comparison would you draw between that type of recommendation for the straight neck mounting as compared to the tapered interference fit mounting?

Where you have a solid mounting on the inner race, what happens to the outer race?

E. C. Denne, Jr.: We certainly recommend turning the outer ring at periodic maintenance intervals. Our suggested practice is to turn the outer ring 90 to 120 degrees to a new load zone depending upon the mill service. Basically, as long as the inner ring rotates (as it does in a mill) and the outer ring is stationary, only a small portion of the outer ring is loaded. This is true regardless of whether the inner ring is applied with a straight bore loose fit or a tapered or straight bore interference fit. Therefore, by turning the outer ring 90 to 120 degrees, a new load zone comes into effect, just as if a new outer ring had been added to the bearing.

The multi-row in its present form was first used in a rod mill in 1947. For rod mill use, to date, the multi-row has been the only anti-friction bearing that I know of that has given satisfactory performance on the very high speed finishing stands. Other types of anti-friction bearings have been tried on these high speed stands, but the results have not been too satisfactory.

On larger mills, the multi-row has not been in service long enough to present a complete comparison. However, many of these mills have been in service over four years and the bearings show no signs of distress.

In changeovers, we can give more definite proof of the performance of the multi-row compared with other type bearings. We have changed over about every type of anti-friction bearing on the market today to the multi-row and in every case, the multi-row has outperformed the previously used bearing by a wide margin. I would qualify that statement by saying that in some of these changes, we have recommended new designs for mounting the chucks in the mill windows, etc. However, there has been no question about the multi-row outperforming the bearing it has replaced.

With the design of the multi-row that we anticipate putting on high speed work rolls, chuck assembly changes could be done right on the mill floor or any convenient location having crane service. This, in essence, is no different from the present practice of applying chucks to roll necks with the loose fit neck mounting with but two exceptions. Since the inner ring of the multi-row would be exposed on the roll neck, it should be thoroughly cleaned before the chuck assembly is applied to the neck. Secondly, chucks should be protected from foreign matter because the bearing rollers would be exposed in the chuck before it was assembled on the roll neck.

C. E. Pritchard: I think specifically what I had in mind there was the possible contamination as of fluids, for example, in the hot strip mill.

E. C. Denne, Jr.: Again, I would only caution that the unmounted chuck assemblies be protected and the necks cleaned before mounting the chuck assemblies. Thus, in more direct answer to your original question, a clean, dry, separate room is always to be desired for bearing changes, but where such a space is not available (and many mills have this problem), I see no reason why such work could not be carried out on the mill floor, presupposing the above stated precautions are followed.

M. D. Stone: Referring to the largest back-up bearing for the 55-in. diameter back up roll—is this a 2-row or 4-row, and what is its rating, first according to your standard method, and secondly for the actual condition based on 15,000 hours average life? Also, what is the rating of the associated thrust bearing, on the same basis as for the radial bearing—and also as a per cent of the radial bearing?

E. C. Denne, Jr.: The multi-row bearing for the 55-in. diameter back-up roll is a four row bearing with a mill duty rating of 7,840,000 lb at 33⅓ rpm and 500 hours. At 42 rpm and 15,000 hours average life, this bearing has a rating of 4,000,000 lb. The rating of the thrust bearing is 453,000 lb thrust at 33⅓ rpm and 500 hours which is 5.8 per cent of the radial bearing capacity.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

By HAROLD R. MILLER, General Foreman, Butler Works, Armco Steel Corp., Butler, Pa.

Protection of Men Exposed to the Hazards of Moving Overhead Electric Cranes

. . . . experience at Armco's Butler plant shows that most accidents on crane runways can be eliminated . . . . an elaborate and well-thought out plan is needed, personnel are required for lookouts, all men involved are carefully briefed, and strict enforcement is mandatory . . . .

▲GENERAL management of Armco Steel Corp. has authorized the publication of four general safety orders. Each of these general safety orders was written as the result of a serious injury to an Armco employee. Each one deals with a specific safety hazard and lists the procedure to be followed by workmen exposed to these hazards. Violation of any provision of an Armco General Safety Order is cause for discharge.

Armco General Safety Order No. 2 was written for the protection of workmen exposed to the hazards of moving overhead electric cranes. It was written as a direct result of a fatality on a crane runway at Middletown in 1922. This was the third crane runway fatality in a span of five years. Since the adoption of the practices outlined in General Safety Order No. 2, we have been able to maintain a clear record in all Armco plants as far as injuries from this source are concerned. Whenever it is necessary for men to go on overhead cranes, crane runways, on top of furnaces or mills, on building structures or any other high place where there is danger of being struck by a crane in motion, the standard practices outlined in General Safety Order No. 2 must be followed.

When work is to be done in these hazardous areas, this general safety order defines the duties of the job foreman, assigned maintenance foreman, the crane operator, and the lookout and members of the working crew. The job foreman is the foreman of the department having the major responsibility for getting the job done. He may be the assigned maintenance day foreman or turn foreman. He may be the foreman of a maintenance shop or the foreman of a construction company.

The job foreman is responsible for following the procedure outlined in this safety order. He is also responsible for enforcing this procedure on all other groups working with him. The foreman of other crafts working on the job must report to him and abide by his instructions. The assigned maintenance foreman is the foreman of a maintenance group assigned to maintain a particular operation. The assigned maintenance foreman may delegate his responsibility as outlined in the safety order to an assistant foreman or to a turn foreman. The crane operator is the craneman assigned to the crane that can enter the area. In many instances there are two or more cranes that can enter the area. In this case, the safety order refers to all cranemen operating cranes that can enter the area. The lookout is a workman from the repair crew or from the labor department who has been assigned by the job foreman to ride in the cab with the craneman. There must be a lookout for each crane that can enter the hazardous area.

This general safety order lists the procedure to be followed under two different situations:

a. The first case is when the crane or cranes in the hazardous area can be taken out of service while work is being performed.

In this case it is the responsibility of the job foreman to consult the assigned maintenance foreman and obtain permission to work in the hazardous area. He must describe to the assigned maintenance foreman the job that is to be done. The assigned maintenance foreman must warn him of any hazards and inform him of any rules and regulations pertaining to the department. He must then have the crane run against the bumpers and open the main crane switch. He shall then write his name on the switch tag with chalk and attach the tag to the switch handle. He shall then assign his crew to the job. When the job is completed, he must notify the assigned maintenance foreman that

the job is finished, then remove the tag from the switch, erase his name from the tag.

b. The second situation occurs when it is impossible to take the crane or cranes out of service while work is performed in the hazardous area.

In this case, the job foreman must have lookouts for each crane that can enter the hazardous area. He may use members of the working crew for lookouts if they are available; if not, he can get as many as needed from a special group in the labor department. This group of men have been trained as lookouts by labor department supervisors, by the safety engineer and by maintenance supervisors. These lookouts are well informed on General Safety Order No. 2 and understand their responsibilities. They are available on short notice, on any turn, seven days a week. When assigned as lookouts, they are issued a badge to wear which identifies them as such. At the time requested, they report to the job foreman at the job location.

Before starting to work, the job foreman must consult the assigned maintenance foreman and obtain permission to work in the hazardous area. He must then assemble the members of the working crew, the assigned maintenance foreman, the cranemen assigned to the cranes that can enter the hazardous area, and the lookouts at the job site. He then explains thoroughly the job to be done. When he is sure each person understands his responsibilities, he shall assign each man to his job.

After the meeting at the job site, the lookouts and cranemen get on the cranes to which they have been assigned. The job foreman will make sure the lookouts and cranemen have reached their positions in the crane cab before any of the workmen proceed to the work area. Under no conditions shall work be done on a crane runway or in an area where there is danger of being injured by a crane in motion, unless lookouts are positioned as required.

The responsibility of lookouts is to ride with the cranemen for the purpose of protecting co-workers by keeping a sharp watch on their position and to warn the cranemen not to operate the crane too close to the man in the hazardous area. Lookouts shall not assume any of the normal functions of the cranemen. They have the responsibility to watch for the hazard they are assigned to guard against. The craneman operates the crane as usual, but the lookout is authorized to order the crane stopped, when in his opinion the safety of any employee is threatened. The craneman must not run the crane into or through the work area, unless authorized to do so by the lookout. The lookout will authorize the craneman to proceed only in case of emergency and then only after all workmen are in the clear and the job foreman has signalled the lookout to proceed.

The assigned maintenance foreman has the responsibility of coordinating relations between the job foreman and the operating department foreman. He must be sure the craneman has been properly informed and that he has safe working conditions. He must be sure the equipment in the work area is not abused. He has the duty to help the job foreman line up the job as it refers to the location of switches, utilities and other hazards.

The craneman has the responsibility to obey the lookout's instructions. In no case shall the crane operator continue to run the crane when there is a difference of opinion between him and the lookout regarding the instructions given by the job foreman. He has the duty to stop the crane and have the job foreman repeat the instructions.

The members of the working crew have the responsibility to use the prescribed safety equipment specified for the job. They shall make sure that the lookout and craneman have reached their positions in the crane cab before proceeding to the work area.

The effectiveness of this safety order depends on the proper assignment of lookouts to the cranes involved. In areas where there is a hazard due to the movement of only one crane, a lookout must be placed in the cab of this crane. In areas where there is a hazard due to the movement of cranes on an adjacent runway, lookouts must be placed in the cab of each crane on the adjacent runway that can enter the hazardous area. On runways having more than one crane that can enter the hazardous area, a lookout is required for each crane. In cases where there are two cranes on the same runway and one crane can be taken out of service, the job foreman shall have one crane run to the bumpers. He shall open the crane switch, write his name on the switch tag with chalk and attach the tag to the switch handle. He will then line up to do the job as if there were only one crane involved. In cases where there are three cranes on the same runway and only two cranes are operating with one of the end cranes not needed, it shall be placed against the bumper and the switch tagged out by the job foreman. Lookouts shall be placed in the other two cranes with the crane operators. Where there are three cranes on one runway and the two end cranes are needed while the middle crane is not, lookouts are required for all three cranes. The unused middle crane requires a craneman also; the lookout is not permitted to stay in the middle crane by himself and be moved back and forth by the end cranes. In areas where three cranes on separate runways are operated by one craneman, and a repair job is to be done on the far runway and that crane is not needed, the job foreman shall have the crane run to the bumpers, open the crane switch and tag it. If the crane is needed, a lookout shall be assigned to it. When the repair job is to be done between the middle crane and the far crane, a lookout must be placed in the middle crane and the far crane. When work is to be performed in the area of all cranes, a lookout shall be required for each crane.

In boarding an overhead crane, the crane must come to a full stop at the access platform or landing. The crane opeator must open the main switch in the crane cab. He must then take a position away from the controls where he can be seen by the person or persons getting on the crane. Before anyone gets on the crane, the craneman shall give a visual signal or verbal instructions to the person or persons desiring to get on the crane. The crane operator and the person or persons on the crane must be mutually assured of a safe position before the crane is moved. When anyone besides the operator gets off the crane, the same procedure shall be followed.

When the design of the crane or building does not provide the lookout in the crane cab a clear view of the men in the hazardous area, it will be necessary for two men to be used as lookouts. One lookout shall be stationed in the crane cab and the other one at a point where he can watch the workmen and signal the lookout in the crane cab. When the craneman is absent from the crane cab, the lookout must stay in the cab or in a position so he can see that no one enters the cab. When the lookout is absent from the crane cab, the crane operator must stay in the cab or in a position where he can see that no one enters the crane cab. Where men are working on or near crane runways and a lookout is required in the crane cab, the crane must not for any reason be operated unless the lookout is in his position in the crane cab. Any emergency deviation from this practice must be prescribed by the immediately responsible supervisor.

When the craneman or lookout relieves at a time different from the regular turn change time for the working crew, he must report to the job foreman before leaving. The relief crane operator must report to the job foreman for instructions before operating the crane. The craneman who has been relieved must inform the job foreman that he has been relieved. The relief lookout must report to the job foreman for instructions before going to the crane. The lookout having been relieved reports to the job foreman before leaving.

When the working crew changes turns, a meeting shall be held at the site before the relief crew starts to work. Those attending this meeting shall include the assigned maintenance foreman, the new job foreman, members of the working crew, craneman and lookouts. The cranemen and lookouts who were relieved before the relief working crew came on the job will attend this meeting. Should anyone be confused as to the proper procedure to be followed, he must stop operations and contact the job leader.

Where it is practical to use them, snap-on bumpers shall be attached to the crane rails. They shall be located a sufficient distance away from the work area to prevent the crane from entering it. The bumpers shall then act as a guide for the lookout to determine his limit of bridge travel. In dark areas, red lights shall be installed at the snap-on bumpers.

In locations having more than one crane on the runway, blinker warning lights have been installed on these cranes. These lights are warning signals for the protection of the crane operator, repairmen or inspectors while lubricating or inspecting the crane or making minor repairs such as changing brushes, tightening bolts, changing contact tips, etc. These lights are not to be used as a substitute for General Safety Order No. 2. Where possible, cranes being serviced and/or repaired, shall be spotted away from the normal work area.

Major repairs on cranes or crane runways, if they are to be accomplished safely, require the maintenance of an extremely co-operative spirit within the repair crew. Riggers, carpenters, electricians, mechanics and laborers must temporarily forego their separate shop loyalties and become co-operative members of the new repair group. In meetings before work begins, each individual must be impressed with his responsibility for the personal welfare of those working with the repair group. Extra consideration must also be given to the regular relief of men posted in semi-isolated locations, particularly lookouts.

This paper illustrates examples of the application of Armco General Safety Order No. 2, but these are not the only situations where it applies. It applies wherever it is necessary for anyone to go on an overhead crane, crane runway, on top of furnaces or mills, or building structures or any other area where there is danger of being struck by a crane in motion.

Strict adherence to these specified procedures require considerable training and planning before work is done around crane runways. However, it is time and effort well spent. We have not had a serious injury to a man doing this type of maintenance work in the 29 years since we started following the practices outlined in our General Safety Order No. 2.

DISCUSSION

PRESENTED BY

H. W. DORSET, Assistant Electric Superintendent, Bethlehem Steel Co., Sparrows Point, Md.

I. N. TULL, Superintendent Electrical Dept., Republic Steel Corp., Cleveland, Ohio

HAROLD R. MILLER, General Foreman, Butler Works, Armco Steel Corp., Butler, Pa.

E. H. HOUCK, Acting Safety Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

JOHN F. KOSTELAC, Assistant Electrical Superintendent, Crucible Steel Co. of America, Midland Works, Midland, Pa.

H. W. Dorset: Mr. Miller and his company are to be commended upon the enviable record of 29 years without a serious injury to men exposed to the hazards of moving overhead electric cranes. We have in our plant at Sparrows Point similar sets of orders governing personnel exposed to these hazards, but unfortunately we cannot boast of such a record. Human frailties being what they are, there is always someone who takes a chance.

Mr. Miller has apparently presented a case or cases in which there is a well-co-ordinated, planned maintenance program for plant maintenance of cranes or runways. I can only assume that the same procedure is followed when there is an emergency breakdown of vital equipment. That seems to be the source from which our troubles stem, with the operating personnel demanding that the crane be put back in service as soon as possible, and we have to get someone out on the job in a hurry.

Safety rules themselves are necessary, but safety rules in themselves do not prevent injury any more than laws prevent crime. I feel sure that the answer to the record cited by Mr. Miller is the enforcement of these rules and the attitude of everyone connected with the job, from the job foreman down to the lowest laborer. It is only with the full cooperation of every man involved, including the mill-operating personnel, that such a record could be established.

I. N. Tull: The protection of workers from injury to

themselves from overhead cranes or, in fact, anywhere seems to be a difficult thing to sell to the men themselves who are exposed to such injuries. They rather resent sometimes the efforts that are taken to save them. It is a very difficult thing to sell, but it has to be sold, as has been said, to the man on the job. It is easy to sell us on top, but we are not exposed to it as often nor in the several ways that the men themselves are.

The results cited, of no fatality since adopting the practices that are shown and talked about, have certainly proved that this can be done. The results as outlined seem to cover most contingencies, and the careful choosing of qualified lookouts or safety men, as we call them in plants shows very careful attention to details. Such men must be of good judgment, familiar with operations not only of the crane but of the general operations and the personnel in the areas covered. There is no place where good and close cooperation among all concerned is of more importance, and I think that was emphasized in the paper.

From time to time we have outside people, such as contractors, working in the plant, and it is difficult to get them to follow the safety way, not that they want to get hurt but mostly because they underestimate the danger. One of the worst offenses they commit is the act of suddenly appearing on a live runway without the cranemen or anyone else expecting them. If they used the regular stair approaches they would see the signs at Republic prohibiting them, as in the plant just cited, from passing without clearance from the electrical foreman in charge. We have very prominent signs at the stairways leading to the runways. Sometimes contractor's men and even plant employees have approached the runways from outside of the building, through a window-way.

I remember a man being killed, who had taken out a louver on the side of the open hearth building, above the runway. He took the louver out and walked in just as a crane came by—and lost his life. Even the lookout would not have had a chance because no one knew inside the building that this fellow was outside and coming in.

I think practically all the instructions, rules and regulations have been covered and well covered. There are two or three questions I would like to ask.

What are your procedures for combating hazards to contractors' people?

Harold R. Miller: We are confronted with the problem that Mr. Tull brings out. The way we have tried to cover it in our Works is to have their supervisors in to our safety meetings to hear our discussion of General Safety Order No. 2. We also have our assigned maintenance foremen get in contact with the outside contractor foreman—that is, the immediate foreman that is coming to work in the area. They discuss the job the contractor is going to do. This contact between the foreman of the outside contractor and our assigned maintenance foreman provides a mutual understanding between them. This mutual understanding of the problems involved makes it easier to carry out the safety regulations effectively.

I. N. Tull: I am not familiar with what you spoke of as a snap-on type of rail stop. Could you describe that for my benefit?

Harold R. Miller: The snap-on bumpers clamp over the rail and have a tapered wedge that is driven in the side which wedges them against the rail. We do not think they are sufficient to protect workmen on a runway. They are used as an additional aid to the lookout, and provide some additional protection.

I. N. Tull: Then they are not simply snapped on with a clip or spring, but actually are wedged on?

Harold R. Miller: They are definitely wedged on.

I. N. Tull: Now, the red lights you use for warnings at these stops; are they battery type or plugged in on circuits?

Harold R. Miller: When we put red lights at the work area, they are connected to the nearest shop supply circuit.

I. N. Tull: We have been experimenting with some battery-operated sets, such as you see sitting in the road, on the highways, for an automobile that stops with a flat tire or is out of gas. Some have a little spotlight on them, white, together with a blinking red light. While they do not look heavy enough, as we have seen so far, we do think that there is a field for such a device and we are following it up.

In connection with lights, I would like to mention—not that it has anything to do with crane labor but it may have—an instance that happened in one of our plants a few weeks ago, where a man put a 32-volt bulb in a 250-volt crane circuit and it blew out in his face. He lost an eye. The 32-volt bulbs are used in locomotive head lights in the plant. They are used in some boiler extension cords where the 110-volt current normally is reduced to 32 by means of a 100-volt portable transformer for elimination of electric shock and danger, but unfortunately the base of the 32-volt lamp was the same as the base of the higher-voltage lamp. We have had this thing up before. There is a real hazard there. We thought we were careful for a number of years but that happened just the other day. I put that out, not that it has anything normally to do with the crane, but it is another hazard to give us trouble.

I think the use of slides and short movies is an excellent way to get the message to the men. A long movie I think sometimes does more harm than good. The audience gets tired of it. If you give them a short movie or a few slides, and elucidate, it has a lot more chance to sell, and there is a lot more chance of their understanding it.

There is one other question, Mr. Miller. Near the beginning of the paper you quoted a penalty of discharge for any violation of this General Safety Order No. 2. Is that a literal or a figurative statement? In other words, how severe is the offense before you have a man discharged for violation of one of the rules?

Harold R. Miller: We have never had an incident that I can point out as a specific example to you, but I would give as an example a cause for discharge; a craneman operating the crane without the lookout in the crane cab after he was assigned a lookout to be with him. That is one of the fundamental parts of the Safety Order No. 2. Any violation of that type would be a cause for discharge.

E. H. Houck: Every accidental injury, of course, has a cause. When these causes have been determined and the means set up to prevent the train of events that

lead to the injury and are carried out—and that is the important part, are carried out—by all concerned, we know that lives are saved.

Mr. Miller's statement that his company has not had a serious injury to a man doing this type of maintenance work in 29 years, since they started following the practice outlined, certainly is remarkable and his company certainly needs to be congratulated.

We in our company cannot say that. We have had failures during those 29 years, I am sorry to say.

The area of maintenance work on or about overhead electric cranes and runways is perhaps public enemy No. 1 in steel plants so far as serious and fatal injuries are concerned. Scarcely a year goes by but what a fatality occurs in some one of the steel companies in the United States, where a maintenance man is either run down by an overhead crane or is caught between the end truck and the building column.

Some other steel companies I am familiar with have set up very similar rules to Armco's General Order No. 2. That includes our company. There are some slight variations in detail, but essentially they are very similar. In some companies they have banners approximately, say, 6 x 8 or 6 x 10 ft, consisting of one-ft squares of alternated red and white squares, or yellow and black in some cases, where in addition to the lookout or watchman or safety man, the banners are strung on either side of the middle crane, if that is down for repair. If one crane is put at the end, the banner is stretched between this crane and the adjacent one. Also in some cases flags are posted in the crane cab as an additional reminder to the craneman that there is work going on in the crane runway.

It may be of interest to know that in some companies, including ours, on new construction, if it is possible and at all practical, we are asking and getting 15 to 18 in. clearance between the end trucks of the crane and the building column. Admittedly, it is costly, but we feel wherever that can be built into new construction, if the man is caught in that area, he has some chance of escaping serious injury from being caught.

I know in some of the older plants the clearance between the end truck of the crane and the building column is only a matter of two or three or four inches, and a man caught there has no chance.

The procedure outlined by Mr. Miller, if carried out, has prevented accidents. Since we have installed a similar plan we have had no fatalities or serious accidents from these planned jobs. However, accidents still continue somehow to occur, but not on these planned jobs, where a job is planned ahead of time and the lookouts are assigned and flags erected and red lights put up. Where we still continue to have trouble is on these so-called minor jobs, mentioned by one of the previous commentators. I am thinking now of a production turn. Something happens to a crane. The craneman can still operate it, or perhaps he cannot. In any case the craneman sends down word for a trouble-shooter, a maintenance man, a motor inspector. The motor inspector goes on the crane runway to answer the distress call and, either through lack of sufficient or adequate communication between him and the craneman or some other reason, he tries to mount the crane, and the craneman does not know he is there or thinks he is still on the runway and in a safe location, and the maintenance man is caught.

In one recent occurrence, along about eleven o'clock in the evening, a craneman had trouble with his crane. He could still operate it, but he still needed some maintenance attention. He called for a trouble-shooter and the inspector went up on the crane runway, where he was in the clear. He talked to the craneman and had the craneman run the crane up and down the runway three or four times to see what the trouble was in a set of gears. The craneman does not know yet what happened, but the man got into a clearance between the building column (8½ in. clearance,) and suffered a fractured pelvis.

Mr. Miller I believe has been asked this question before and has answered it, at least to some extent, but I would like to ask the question again. Has he had any trouble, not from these planned jobs where the lookout and the flag and so forth are set up—we are sold on that particular phase of repair work—but has he experienced this trouble, and I am speaking about the so-called minor trouble-shooting job which only involves the craneman and motor inspector or one man that goes up to look for the crane trouble?

Harold R. Miller: Mr. Dorset and Mr. Houck bring up a point on these minor jobs, these short breakdown jobs. If any of our repairmen must go on the runway, as far as we are concerned, it is a major job.

If we have a little job to do on the crane itself, where there is no danger of being hit by another crane on the runway, the inspecting of the crane would be an example, we use blinker lights.

We have blinker lights on all cranes where there is more than one crane on a runway. That is a project we just took on within the last couple of years. Our purpose in doing it was to protect the repairman while he is on the crane itself. For example, he could possibly be bumped hard enough with the other crane to knock him off the trolley. So we have this control to operate at, 250-volt, d-c that signals by means of the red light. With some cranes we put two on the bridge to hang down about the same distance as the regular bridge lights and one in front of the crane cab, right below the front glass in the windows. The circuit is connected ahead of or on the feeder side of the main switch on the crane bridge. We close this switch and get about 30 flashes a minute with the control. It shows up very well.

Our safety order stems from top management, which we think gives it very good support. We can enforce it. We think we have enough men involved in our setup to provide a system of checks and balances. If one fellow wants to take a shortcut, we always have somebody else with a different response that we believe gives us that check.

John F. Kostelac: Have you tried the use of a low-frequency transmitter or receiver in conjunction with a tape recording system? We have installed such a scheme at a dangerous railroad crossing. When a train approaches the danger zone, the low frequency transmitter operates the receiver which through a relay starts a tape recorder. Any desired message can be sent warning the employees of the existing danger. A similar system can be applied to cranes and perhaps eliminate the lookouts.

Harold R. Miller: We have not tried that. I do not know whether it would be effective or not.

By
WAYNE BELDEN
President*
Ajax Flexible Coupling Co., Inc.
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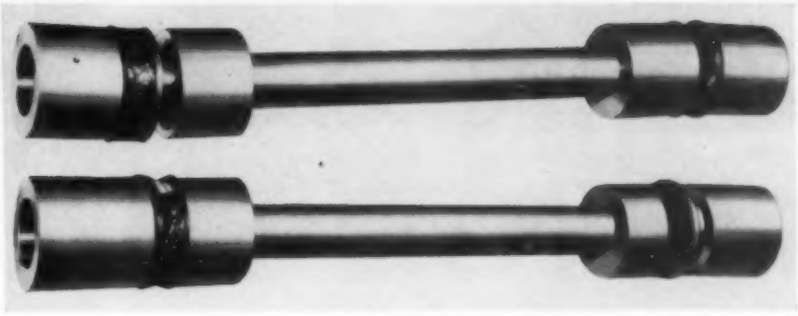


CURRENT DEVELOPMENTS IN SPINDLE COUPLINGS

. . . . the spindle coupling has been in operation a relatively short period . . . . some of the installations have shown substantial reductions in maintenance costs and operating expense, and have increased roll life between grinds . . . . product has been improved . . . .

▲IT is assumed for purposes of this paper that the reader is familiar with flexible or self-alining couplings used in the transmission of power. Their purpose is to connect two shafts so that when one is rotated the other must also rotate in the same direction and at the same speed, in spite of the fact that two independently mounted shafts will not rotate on the same axis, but will be more or less out of line.

The coupling under discussion is a modification and development of the standard gear type coupling used throughout heavy industry for the past forty years or more. Spline type coupling would be more accurate, since the parts do not function as gears but as splines, and the usual formulae applied in gear design are invalid.

The basic idea is simply two splined shafts and a splined collar, as shown in Figure 1. It is apparent that by inserting each of the shafts in the splined collar, that when one rotates the other must also rotate in the same direction and at the same speed. If the splines are a loose fit, the shafts will turn together, even if somewhat out of line, and with a greater or less degree of satisfactory operation.

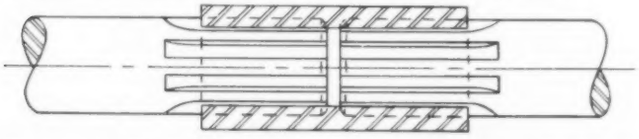
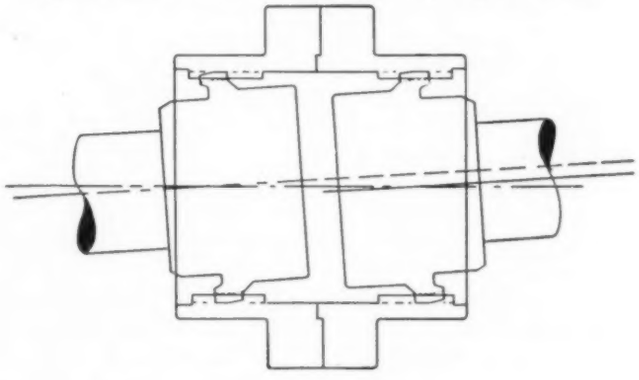


Figure 1 — Basic idea is the use of two spline shafts and a spline collar.

Figure 2 — Elements of standard coupling are shown.



In actual practice the shafts are not splined, but splined hubs mounted on the shafts are substituted. Also to facilitate installation and maintenance, the collar is split into two flanged halves, which are bolted together and which in effect are assembled into a continuous ring or collar.

The essentials of the standard coupling are shown in Figure 2. Note that the ring floats on the two hubs, making what is known as a double engagement coupling. The prime object of the double engagement coupling is to reduce all shaft misalinement to angular misalinement, which ordinarily will be taken care of one half at each end of the coupling.

The capacity of each half of the coupling to successfully transmit power under angular misalinement remains constant. The amount of shaft offset that can be converted to angular misalinement is a function of the distance between the two operating ends of the coupling.

To increase the offset capacity of the standard coupling, the two halves are separated, either by a spacer or by a floating shaft, as shown in Figure 3.

For about twenty-five years the splines on the hubs and in the housings were straight splines. The misalinement capacity of the coupling was controlled

* At time of paper presentation.

strictly by the amount of tooth clearance or backlash between the ring and the hub. No lasting or significant attempts to make substantial changes were made until approximately fifteen years ago. At that time a modification in the straight tooth on the hub was tried and proved successful.

Two modifications of the original straight tooth hub gear are in current use. Both of these modifications have one object, namely to increase the capacity of the coupling to operate under angular misalinement with a minimum of tooth clearance or backlash. The comparative merits of the various ways of modifying a straight tooth coupling to obtain the best results will not be a part of this discussion.

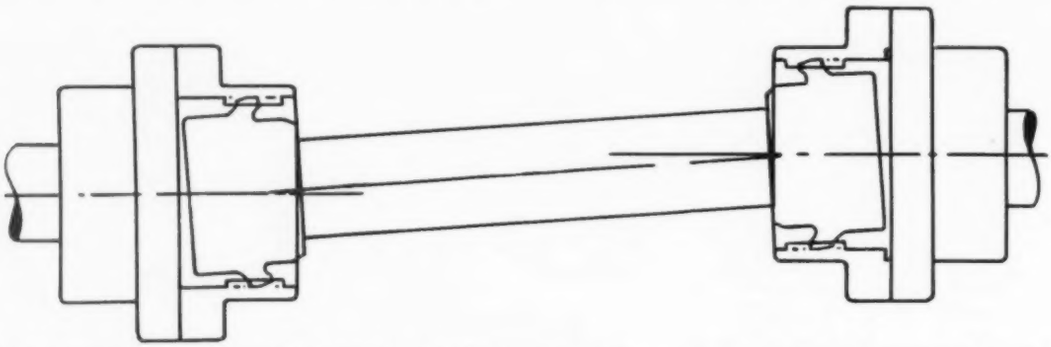


Figure 3 — Separation of two halves increase offset capacity.

Over a period of several years these modified tooth couplings were used in substantial quantities in heavy duty service and under substantial misalinement, such as on the main drives of surface transportation cars; on auxiliary drives in aircraft, such as cabin compressors; on the driving mechanism of large bridge cranes; and in other places where misalinement made it impractical to use the conventional straight tooth coupling.

The success of the modified tooth coupling on a variety of applications led to attempts to adapt the coupling to rolling mill drives, as a part of the general program of increasing roll speeds. Up to about five years ago, experience on roll drives had been with a different type or types of joints, so the coupling manufacturer and the steel roller alike were faced with many problems new to everyone.

The operating advantages of the coupling stem from the fact that they are made from accurately machined forgings in contrast to the more or less rough castings that had largely been used previously. Accurate machine work coupled with sound basic design is what gives the coupling its constant angular velocity and its freedom from backlash, characteristics both desirable and in fact essential to the successful operation of high speed mills. These characteristics are such that the coupling requires a little different treatment in the hands of operating and maintenance personnel from the joints previously used. Sometimes certain basic data required to engineer a satisfactory installation, such as peak torque loads or maximum misalinement under any condition, has been either lacking or erroneous.

The existence of a variety of roll ends on which to mount coupling boxes presented a manufacturing problem. Most steelmen are familiar with various roll ends, such as are shown in Figure 4. However, time, experience, suitable machinery, and a lot of mistakes have solved the problem of properly fitting all of these different roll ends with a satisfactory coupling box.

The problems already mentioned, although serious and time-consuming, were comparatively minor problems. The really big problem first encountered was how to change rolls rapidly without damage to the coupling or boxes and to maintain at the same time proper lubrication. The problem was perhaps aggravated by the fact that proper and complete lubrication of the coupling is essential at all times, for even momentary operation without lubrication or with inadequate lubrication easily results in complete failure. It took the complete cooperation of the mill builder, the plant engineer, the operating and maintenance engineering departments and the coupling manufacturer to work out satisfactory solutions to this tough problem of roll changing. It took some considerable time to try out the various reasonable looking ideas that were advanced, and to iron the problems out of those that proved to be sound. It is a source of great satisfaction to all who have worked on these problems to realize that today as a result of their combined efforts there is a growing fund of knowledge that enables the coupling manufacturer and the mill builder to follow with a reasonable certainty of success a growing list of standard practices.

The rolls on some mills are changed horizontally and others vertically. The horizontal changeover was the more difficult of the two.

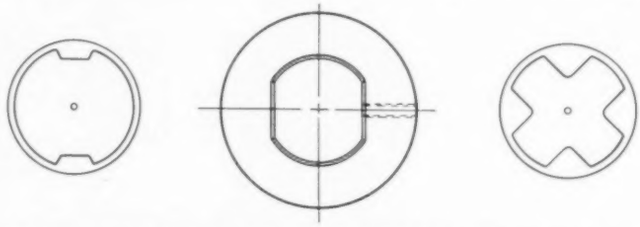


Figure 4 — Common roll ends to which coupling box must be mounted.

Figure 5 shows a complete spindle with a coupling at each end. This sketch can be said to embody the latest proven details of construction, designed to facilitate horizontal roll change together with maintenance of correct lubrication, long life and satisfactory and profitable operation. The pinion end at the left is almost a conventional single engagement coupling. An extra ring is added to the pinion or female half of the coupling to serve as a seat for a conventional clipper-type grease seal, which is mounted on the pinion shaft coupling hub. This end of the coupling is not disturbed during roll changes, so the lubricant is well retained and danger of failure from lack of

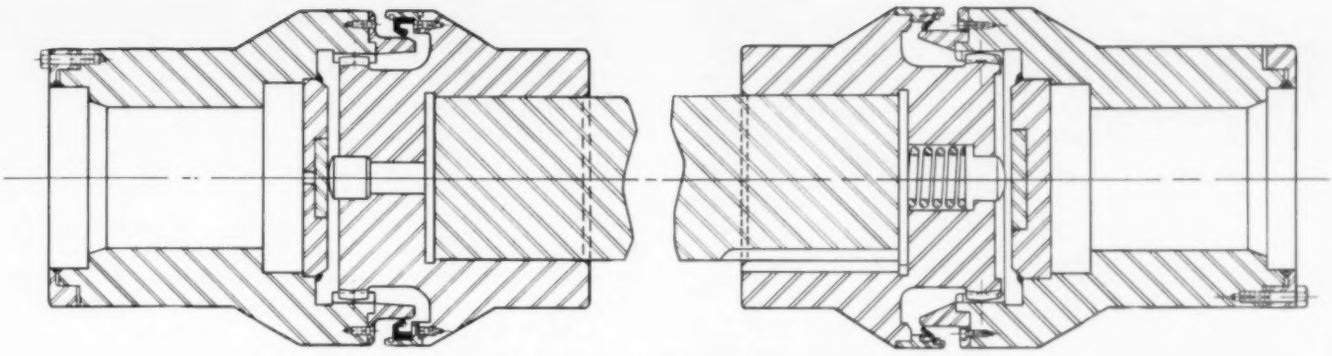


Figure 5 — Complete spindle is shown with coupling at each end.

lubricant is remote. A periodic check with renewal of lubricant at suitable intervals is all that is necessary.

The mill end of the coupling is a little different and is shown in more detail in Figure 6. The coupling box, or that half of the coupling which is mounted on the roll itself, is a good press fit on the roll end. It is pressed on but in this particular case is removed hydraulically, and you can see the fitting used for that purpose. This work is done in the roll shop, and it is standard procedure to keep rolls with the coupling boxes mounted ready for immediate replacement service.

One detail that helps to make roll changing safe and easy is the spring-loaded thrust button. A hard plate mounted in the coupling box on the roll end comes in contact with the hard button in the end of the spindle when a new roll is swung into place. In normal operating position, the thrust button does not contact the plate. Some spindles have been made with spring-supported thrust buttons at both ends, and others have been made with one fixed thrust button and one spring-supported as you saw in the sketch.

To facilitate roll changing, the teeth of the coupling are lengthened a little on one side, and the ends of the teeth are beveled. When the roll is brought into position ready to reconnect to the spindle, the coupling teeth mesh readily. This is a simple and effective self-piloting entry device, shown on Figure 7.

Figure 8 shows a similar spindle but with a different type of grease retainer. This type of construction is used where it is necessary to keep the coupling boxes to the smallest possible diameter. The clipper-type of grease retainer requires a coupling box at least with a lip of sufficient diameter to permit the operation of the seal outside of the rest of the hub. In Figure 8 the grease retainer is a neoprene impregnated canvas boot. At the spindle end, which is not disturbed during roll changes, the boot is fastened firmly to the box and to the hub with a metal band. At the roll end, in addition to the neoprene impregnated canvas, the boot is spring wound, so that when the coupling box is removed, the boot remains substantially in operating position.

This is perhaps a good place to bring up the subject of spindle carriers. When in operating position, the spindle is supported by the couplings, one at each end. When a roll is pulled, the roll end of the spindle will drop unless it is supported. If it drops past the engineered degree of angular misalinement capacity of the coupling, then the pinion end of the coupling will almost surely be damaged severely. So it is essential to provide a spindle carrier that will support the spindle during roll changes in approximately the operating position.

On the other hand, there is evidence to indicate that any spindle-carrying device that interferes in any way with the free movement of the spindle when the mill is in actual operation will interfere with the proper functioning of the coupling and will result in too rapid deterioration. A spindle-supporting device that will support the spindle as closely as possible to operating position, and which can then be withdrawn completely after the roll change has been made, has proven in actual operation to be sound practice.

Figure 9 shows a small spindle coupling as applied to

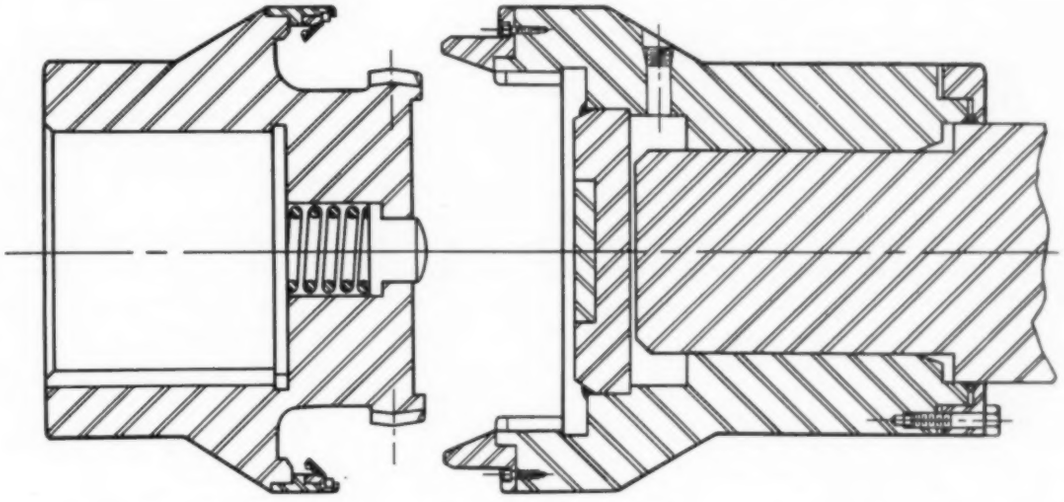


Figure 6 — The mill end of the coupling is slightly different from the conventional single engagement coupling.

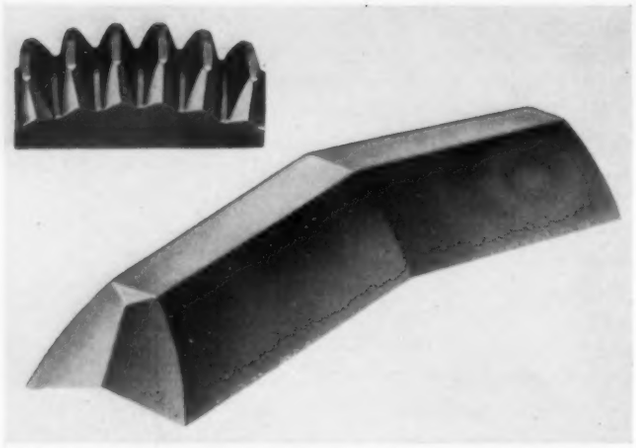


Figure 7 — The teeth of the coupling are lengthened a little on one side and the ends of the teeth are beveled.

a rod mill, where the rolls are removed vertically. The spindle end of the coupling is mounted permanently in a conventional manner. The roll end of the coupling is mounted with a plain flange machined for a nice slip fit on the flattened roll end. In operation it is held in position with two hollow head set screws, so that it cannot come off the roll. The ring gear of the coupling is made approximately six in. longer than standard. Also the ring gear at the spindle end of the coupling is longer than standard in the same way. When in operation, the position of the coupling hubs on the spindle shaft are as shown in Figure 9.

When it becomes necessary to change rolls, the set screws are removed from the flange on the roll end. The whole roll end assembly is then pushed toward the center of the shaft, and likewise the spindle end of the assembly travels toward the pinion stand. On this particular installation, the assembly will collapse a

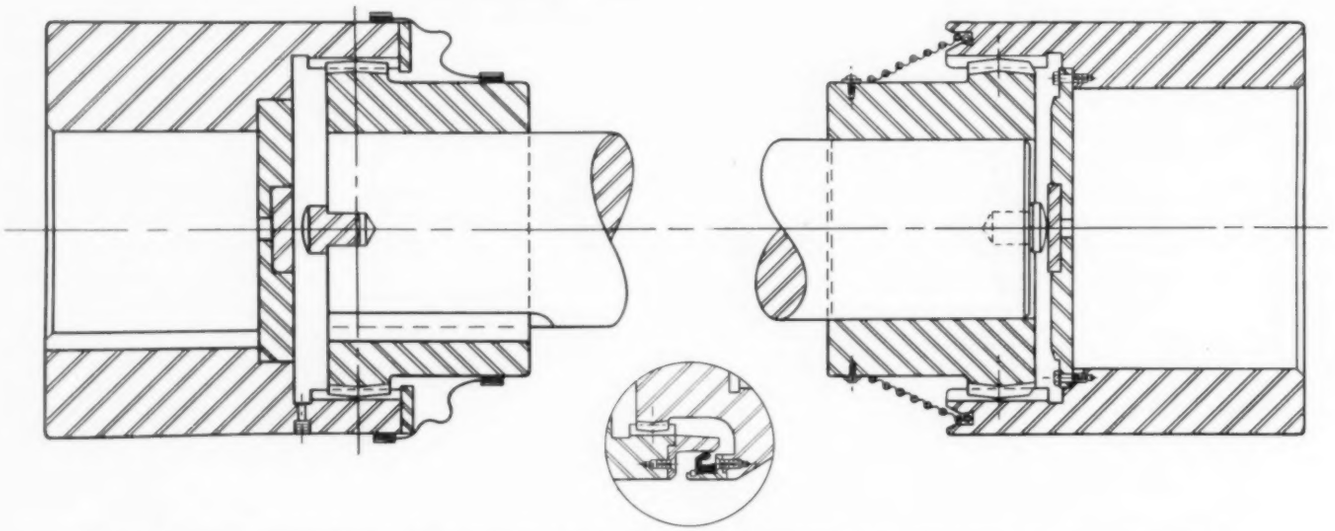
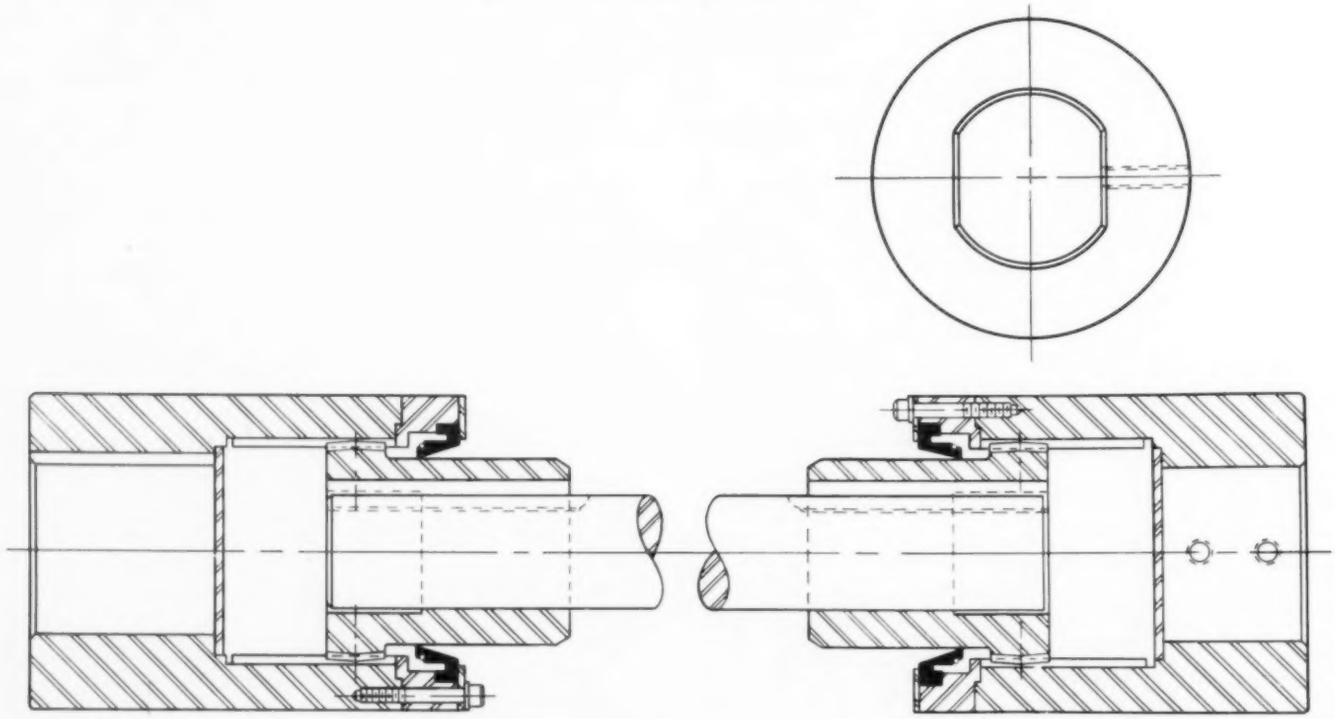


Figure 8 — Grease retainer on this coupling is designed to keep coupling box to smallest possible diameter.

Figure 9 — Rod mill spindle coupling.



total of twelve in. or a little more. This frees the roll with room to spare and permits easy and quick disassembly.

These few remarks and sketches cover some of the highlights of developments in spindle couplings as of today. Other developments and ideas have been incorporated in spindle couplings now being manufactured, but proof of the soundness of any of these later ideas awaits a period of actual operation long enough to prove or disprove their worth.

Although the spindle coupling, as such, has been in actual operation for little more than four years, there are in actual operation an estimated twelve to fifteen hundred spindle couplings on rolling mills of various kinds. Some of these couplings have done an outstanding job, showing substantial reductions in maintenance costs, in operating expenses, in increased roll life between grinds, and in improved product. With growing knowledge of pitfalls to be avoided, and with wider experience and training on the part of operating men and plant engineers, coupling installations that turn out to be something less than satisfactory are rapidly disappearing. Without a doubt the coupling, as used on high speed mill spindles, is handling well a tough job in current mill practice, and will continue to do so within the foreseeable future.

DISCUSSION

PRESENTED BY

W. E. MATTHEWS, Superintendent Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

WAYNE BELDEN, President, Ajax Flexible Coupling Co., Westfield, N. Y.

J. GUY GRIFFITH, J. Guy Griffith Co., Pittsburgh, Pa.

E. C. DENNE, SR., Manager, Gear Dept., United Engineering and Foundry Co., Pittsburgh, Pa.

F. H. PADDON, Manager-Engineering Sales, Amerigear, Salem, Ohio

LOUIS MOSES, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

W. E. Matthews: Mr. Belden's paper has been of great interest to me for we have recognized the need for a different type coupling on spindles of high speed mills. The conventional universal coupling with segments becomes an expensive item to maintain as speeds increase. For this reason, a few years ago, a gear type coupling was designed and made at Sparrows Point in search for an improved spindle coupling. Since that time, we have installed this type coupling on a skin mill.

Our experimental coupling was made with the curved flank tooth and the backlash had to be increased to provide for angularity. As stated by Mr. Belden, the worst abuse is roll changing, not actual angularity of operation. For this reason, we have wondered why the manufacturers of the gear type couplings have not gone to better materials and increased the size of tooth; also since it is a spline and not a gear, why have they stuck to gear tooth shapes. We also note that most installations have been on skin mills or what we consider light loaded mills; are there any on highly loaded mills such as tandem mills with heavy reductions?

Wayne Belden: As far as I know, couplings have been used on high speed mills only. Also I believe that the older types of universal joints have been less expensive with less maintenance on the heavier and slower mills.

J. Guy Griffith: There is one installation now that is operating very satisfactorily. It is the one at the Allenport plant of the Pittsburgh Steel Co. We are looking forward to a very successful operation on the No. 7 mill at Weirton which will be starting in May 1956. It is a heavy-duty mill, it is a high-speed mill. Dihedral couplings are installed on that five stand line. We hope soon to get more information on this installation, which is one of the largest installations that has been made to date.

Wayne Belden: The other part of Mr. Matthews' question had to do with the size of the teeth. I believe that as the tooth size is increased, the amount of tooth clearance or backlash also has to be increased. Also, you will get further away from a constant angular velocity.

E. C. Denne, Sr.: I have been somewhat exposed to the gear tooth type mill spindle and considering that there are fixed space limitations, it is necessary to consider many factors in the design for their best operation.

1. Since angularity of spindle affects the amount or magnitude of tooth contact, it is important to keep its angle within practical limits.

2. From a wear standpoint, it is desirable to have fine pitched teeth, in order to increase the number of contacts in the load zone, thereby reducing the unit pressure on each tooth surface. This may not be advantageous from a roll changing standpoint, as many coupling failures have occurred during this period.

3. The coupling tooth face should be kept to a minimum. The longer the face, the more chance that the teeth will bind when changing rolls with spindle in a high angle position. In addition, it is probably desirable in some cases to remove the ends of each tooth, full depth, about 45 degrees. In general, this part of the tooth is not used, and its removal will help to decrease the interference binding, caused during high angle roll changing, without affecting the tooth strength under normal operating conditions. This removal produces additional reservoir for the lubricant and places the lubricant nearer to the load, or high specific sliding contact zone.

4. It is, of course, important that the couplings be accurately machined with teeth accurately spaced, and cut, so that the load is uniformly divided among the teeth in the load zone as accurately as possible. The coupling in tandem mill set-ups, for practical "spare" purposes, must be designed to suit "high torques at slow speeds," and "low torques at high speeds." This places additional limitations on the coupling design. It is desirable in the "high torque at slow speed coupling" application to make the coupling large in order to increase its load carrying capacity. On the other hand, it is desirable to keep the diameter or size of the "low torque at high speed coupling" to a minimum in order to reduce the specific sliding when it operates at an angle position. The above variable conditions exist in

a 5-stand tandem cold mill spindle application. Suffice it to say that the coupling practice today is to make them as large as the tandem mill rolls will permit.

It can readily be seen that it is desirable to have a high strength material, with a high hardness case with teeth accurately spaced and generated, and fine tooth surface finish. All sharp corners should be removed.

5. It is important to have an ample lubrication reservoir for proper lubrication of the small load zones near the center of the teeth. The lubricant must be suitable for the "high load slow speed," and the "low load high speed" conditions.

6. It is desirable to have the coupling portion of the mill spindle designed so that it can be readily removed, and quickly replaced by another interchangeable one, without removing the mill spindle.

7. Spindle carrier should not be used during the working cycle of the spindles. The teeth in the coupling should be permitted to find their own contact without any outside influence or unbalanced load which a spindle carrier can produce.

Much has been learned about the operation of gear tooth mill spindles during the past few years, and there is no question but that they are a must in many applications in the steel and non-ferrous industries.

F. H. Paddon: This is a new problem and we are all doing a lot of research, but have a long way to go yet.

In the high maintenance spindle installations, application of gear type spindles result in reduction of maintenance cost, increased net operating time, and product quality improvement. This paper pointed out the need for spindle improvement with existing problems, that in detail exposes problems that gear type spindle go a long way in solving.

In talking slipper type couplings, we had indications of lack of sufficient slipper area to transmit desired load at the working angle. The need for rewelding of pod type spindles with hard-facing indicated that the load area is not functional or adequate. This all adds up to inadequate materials and load areas, which increase tooth contact loads beyond the limits of lubrication.

Mr. Belden indicated there are several methods of cutting or modifying gear type spindle teeth. For given spindle applications, the selection of the basic tooth is critical. Various tooth modifications should be considered as to ideal shape and greatest load area with true universal action. This is the same problem as with slippers. Various modified gear teeth each have their own characteristic capacity curves depending on tooth shape, and all vary with operating angle. Teeth should be selected to meet full load operating angle with adequate allowance made for no load or roll change angle. Previous overlooking of these requirements, to manufacturers regret in some cases, resulted in spindles that had adequate capacity at full load angle, that failed when no load angle was exceeded during roll change.

In conclusion if spindles are properly selected for a defined application, improved mill utilization and operation can be obtained effecting direct economies.

W. E. Matthews: I asked the questions due to conditions encountered in actual operations. I had reference to tooth size and materials to overcome abuse under operating conditions such as roll changing where the spindles are raised with the load on the teeth of the coupling and better wear capacity by heat treating the teeth. A larger tooth will have more beam strength, and better materials, such as AISI-4640 or 2340 properly heat treated, will add further to the resistance to breakage and wear. We have found most conventional gear type couplings have been made of AISI-1040 to 1045 plain carbon steels. As to torque capacity, I believe most coupling designs I have seen will carry the loads they are designed for under normal operating conditions.

Wayne Belden: All I can say to that is that all the alloy steels have been tried. I believe that most of the couplings today are being made of SAE 1045. The surface is good and I do not think that we have seen any couplings teeth that have been broken off except if they have been hammered. We have seen plenty of them where the surface deteriorated in a very short time. The strength of the teeth is adequate. I think Mr. Paddon will agree with me that the surface of the tooth is the problem.

Louis Moses: Mr. Belden, in describing the problems encountered in the developments of gear type couplings, for rolling mill drives, has confined his paper to the engineering aspects. He does not touch upon the advantages which the coupling offers to operations.

Some twenty years ago the introduction of a gear-type coupling solved a very difficult problem wherein a constricted distance between rolls and pinions made it impossible to use conventional pod type spindles and boxes. Prior and subsequent occurrences clearly revealed the contrast between the two methods of delivering power to revolving rolls.

There is scarcely an experienced operator of rod mills who has not, at one time or another, had a condition of gage variations spaced some 30 in. apart in his rolled rod. These occurrences have no less frequently been ascribed to eccentrically turned rolls. On one occasion the mill people completely ignored the fact that the offending removed rolls were proven to be accurately turned within close limits of a few thousandths. However, during the roll change, the observant roll turner noted that the badly worn coupling boxes were replaced by new ones. Be sure that a repetitive case was handled, not by a roll change, but by merely changing coupling boxes and spindles, when that instance of gage variation disappeared. This was a clearly defined case of what can be termed "roll pounding" wherein the violent throw of the boxes created vibrations which could not be dampened or absorbed by the bearing-housing assembly and caused the rolls to run out of balance. This condition can and has extended to roll stands ahead of the finishing stand with the product marred because no finishing pass can completely iron out irregularities in the leader bar.

Another instance concerns the centerless grinding of 0.006 in. from the diameter of quality round spring stock. Bar waviness was sharply apparent by unground depressions remaining on the bar surface, these being evenly and regularly spaced thoughout the bar length. The condition was found to be due to spindle angularity. The circumference of the roll, divided by four (representing the four wobbler pods), matched exactly with the spacing of the depressions. A closer alinement of roll diameters to the pinions cleared up the difficulty, but it is obvious that rolls cannot be maintained at pinion pitches.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, April 29, 1957—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Cold Extrusion of Artillery Shell," by T. H. Burns, Technical Director, The Central Foundry Co., Shell Plant Div., Holt, Ala.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, April 9, 1957—Dinner 6:30 P.M., Meeting 8:00 P.M.

Inspection Trip—Welland Tubes, Ltd., Welland, Ont., Canada.
"The Big Crossing," 35 min. colored film gives details of the longest pipeline in the world which runs from Western Canada to Sarnia. After film—J. Farquhar, Supt., Welland Mill will conduct questioning period regarding the mill.

Prudhommes Gardens, Vineland, Ontario

CHICAGO SECTION

Tuesday, April 2, 1957—Dinner 6:30 P.M., Meeting 7:30 P.M.

"The Outlook for Natural Gas Supply in the Chicago Area," by R. McDowell, Vice President, Finance and Public Relations Div., Peoples Gas, Light and Coke Co., Chicago, Ill.

Phil Smidt's Restaurant, 1205 North Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, April 16, 1957—Inspection Trip 4:00 P.M., Dinner 6:30 P.M., Meeting 8:00 P.M.

Inspection Trip—American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio
Panel discussion on inspection trip, moderator, F. A. Garman, Chief Engineer, American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio

The University Club, 3813 Euclid Avenue, Cleveland, Ohio

DETROIT SECTION

Tuesday, April 9, 1957—Dinner 6:30 P.M., Meeting 8:00 P.M.

Election of Officers

"Spray Lubrication," by Edward Gesdorf, Senior Application Engineer, Farval Corp., Cleveland, Ohio
"Non-flammable Fluids for Hydraulic Systems," by W. D. Matthews, Product Manager, Celanese Corp., New York, N. Y.

Dinner and Meeting—Parlors E, F, and G, Horace Rackham Educational Memorial Building, Detroit, Mich.

LOS ANGELES SECTION

Monday, April 8, 1957—6:30 P.M.

"Electric Steel Manufacturing on the West Coast," by W. E. Lewis, Vice President of Sales, Lectromelt Furnace Co., A McGraw Electric Co. Division, Pittsburgh, Pa.

Rio Hondo Country Club, 10627 South Old River School Road, Downey, Calif.

PHILADELPHIA SECTION

Saturday, April 6, 1957—Dinner 6:00 P.M., Meeting 7:00 P.M.

"Choosing the Right Fastener," by William P. Acres, Assistant to General Manager, Lebanon Plant, Bethlehem Steel Co., Lebanon, Pa.
"Steps in the Development of Automatic Thickness Controls for Rolling Mills," by I. G. Orellana, Senior Project Engineer, Electrical Laboratory, Republic Steel Corp., Cleveland, Ohio

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, April 8, 1957—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Crane Symposium

"Dual Bridge Drives for Overhead Travelling Cranes," by W. J. Tunny, Superintendent, Electrical Maintenance, Youngstown Sheet and Tube Co., East Chicago, Ind.
"The Proper Installation and Maintenance of Electronic Control Systems," by J. W. Bauer, Jr., District Sales Manager, Femco, Inc., Irwin, Pa.
"Application of Cushioning Material under Crane Rails and Results Obtained," by K. D. Cunningham, Assistant District Engineer, American Bridge Div., United States Steel Corp., Pittsburgh, Pa.

University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Wednesday, April 24, 1957—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Details not available.

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

No April meeting

UTAH SECTION

Monday, April 8, 1957—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Water Development of the West," by E. O. Larson, Regional Director, U. S. Bureau of Reclamation

Skyliner Cafe, Provo, Utah

YOUNGSTOWN SECTION

Monday, April 22, 1957—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"General Electric Activities in Metallurgy and Ceramics Research," by R. K. McKechnie, Manager, Process Laboratories, Metallurgy and Ceramics Research Dept., General Electric Co., Schenectady, N. Y.

Mahoning Country Club, Girard, Ohio.

. . . . transportation control in steelmaking has entered cost areas governing such items as track maintenance, use of industry locomotives and iron ladle operating costs . . . . studies have improved many material handling methods and led to extended use of special equipment . . . . a better understanding of the elements which minimize handling costs has been attained . . . . much work remains to be done to get transportation control out of the field of pseudo-science . . . .

TRANSPORTATION CONTROL IN

By

J. L. KERINS

General Transportation Manager

United States Steel Corp.

Central Operations

Pittsburgh, Pa.

▲ TRANSPORTATION is a synonym for the handling of materials, and in the most extended sense, encompasses the movement of goods and products from points of origin to those of consumption.

A definition to express the scope for the function of transportation could be the following:

To assemble materials for manufacture, and distribute products of production, at the lowest attainable costs resulting from policies of sound management, while maintaining stability of movement-flow with minimum damage.

The intention of this paper is to review, with objective generality, forms of transportation control that are presently being utilized by one steelmaking organization to attain those benefits expressed in the above-mentioned definition for the function of transportation.

For this paper the author will limit the discussion to his field of activities in the role of general transportation manager for the operating department of central operations.

For the purposes of this paper the term central operations will be used to designate the steelmaking plants of the United States Steel Corp. that are located at South Chicago, Gary, Youngstown, Pittsburgh, and Fairless.

Perhaps an imaginary illustration at this time would serve the purpose of clarification. Should one ascend to stratospheric heights above any large industrial area, and visibility were right, he could see below the lifelines for industry as represented by rails, rivers, roads and conveyors. These are the arteries that keep the body of manufacturing alive; they represent the basic elements for material handling. Industry identifies the use of these facilities as transportation.

Industrial producers make multiple applications of material movement, but the assembly of automobiles probably comes as close to realizing desired aims for material handling as any manufacturing technique. In this instance, the total concept of handling has been integrated to close scheduling, uninterrupted flow, negative damage and low cost movement expense.

The automotive industry early realized that establishing a primary conveyor line with the ability to absorb 100 chassis per hour, while feeding engines to this conveyor at a rate of 75 per hour necessarily "pegged" production to 75 automobiles produced per hour. With application of control techniques over material handling, the automakers concentrated on the problem of realizing proper balancing to operations under maximum rates of material flow. This, in essence, was transportation control.

DETERMINING THE OBJECTIVES OF TRANSPORTATION

The author would like to discuss some of the methods by which the objectives of transportation in central operations of United States Steel are sought, and those controls that are utilized to assist in the realization of basic corporation aims of making and selling quality products competitively.

Fundamentally, it is necessary to know what performances are being experienced in an operating function prior to working toward any improvement to the results. Central operations the past three years has been developing and installing transportation controls to indicate what is being received in the way of material handling performances, what the performances cost, and then using these experiences to accomplish better methods.

A cost relating to material handling should be considered a standard charging rate, and for which a standard performance should be received.

In earlier days when labor rates were much lower, and many of the prime elements of transportation

leaned heavily to manual operations, the cost impact of handling and movement was secondary in importance. Today, mechanical transfer has become the basic material handling factor, with its cost increasingly assuming a prominent part of manufacturing expense. Such a metamorphosis has necessitated realistic evaluations of the elements comprising the function of transportation, and thus a resultant use of expeditious and effective controls that enable management to smoothly gear its operating conditions to rapid change and varying conditions. Cost controls, concise in nature, have become a must tool to effective management planning.

DEVELOPMENT OF TRANSPORTATION COST

What is the practical scope of transportation cost, and how best should it be controlled? The number of responsibilities that will make use of the collected data, as well as how soon after the facts the information

can be accumulated, are guides to the scope of analysis desired. In central operations the development of transportation cost is approached in two ways:

1. The material handling costs developed for transporting a commodity from its point of origin to the completed delivery at a plant. During the discussion this will be referred to as Phase I cost.
2. The material handling costs developed when processing materials into products, and the handling of these products to the points for shipment, hereafter, referred to as Phase II cost.

This would be an appropriate place to evaluate, in some detail, the component parts that make up these phases of transportation cost control; to indicate those elements which are providing the most effective management tools; and to focus attention upon areas where weaknesses still exist in the search for objective planning.

PHASE I COST

This transportation cost consists of those expenses incurred in transporting materials to destination points for production, plus related expenses required to unload. The report form has been developed on a commodity basis and recapped in a manner that posts the handling and transportation expense for each individual plant. Each commodity reflects the total tonnage handled during a month by the respective plants together with the transportation costs per ton. This type of recap makes possible, horizontal comparison of plant costs by individual item.

Initially these cost reports were developed on a monthly basis, for the purpose of review and discussion in the transportation meetings of central operations. Gradually from the experience gained, these reports have gone through a general change so that today the emphasis is being placed upon more detailed analysis of individual commodities, with an over-all report being issued twice a year.

This form of transportation cost control is supplying much assistance toward an effective direction to cost reduction applications.

PHASE II COST

These in-process transportation costs can best be described as consisting of those factors of transportation necessary to manufacture steel products together with the transportation elements required to handle the by-products of the manufacturing.

It is in this field of control that central operations is exerting its greatest amount of study and development work, and installing the most effective controls. For this facet of transportation the field is unlimited.

What elements go into Phase II costs? The following are some of the obvious ones:

a. Terminal transportation services performed by narrow and broad gage railroad equipment.
b. Maintenance of transportation facilities, such as tracks, roadways, and scales.
c. Outside purchased transportation services, including use of leased trucks.
d. Equipment damage expense.
e. Demurrage and weighing charges.

These cost considerations that have been mentioned, as well as several others, are expressed in total dollars expended for the various determinants, and for the costs per ton of material handled. For example, open hearth area transportation charges are stated as "dollars per ingot ton produced," and finishing mill transportation expenses as "dollars per ton shipped."

USE OF TRANSPORTATION COSTS

In central operations, the analysis of total transportation costs of each plant is completed immediately following the close of an operating month. Costs accumulated for approximately twenty separate elements of transportation are assembled according to major operating responsibilities within each plant; such as by coke works, blast furnaces, and open hearths.

Costs are expressed as "what has been spent compared to what should have been spent" in performing each of the elements of transportation. The dollar differences between these actual and standard practices are expressed as variances. Favorable operating improvement over an allowed budget is designated as a black variance; whereas, unfavorable deviations from allowable costs are referred to as red variances. This information is supplemented by an essay-type analysis explaining causes for deviations as well as possible corrective actions planned for the future.

Such analyses are developed for all plants and become part of a monthly cost brochure issued to the plants approximately a week in advance of the regular transportation meeting with representatives from all plant transportation responsibilities. At these meetings,

transportation costs are reviewed for the purpose of developing methods that will realize improved practices in the future.

Individual graphs plotting plant and total corporation trends for transportation performances, are included in the cost brochures. The incentive is there to incorporate newest methods as may be indicated from best cost experiences obtained.

To develop and install method improvements in plant transportation activities, subcommittee work is used extensively. These groups, working for the transportation committee of central operations, are given the responsibility for making detailed operational analysis of specific transportation activities, and developing recommended improvements. Subcommittee reports of findings are submitted to the full assembly of the transportation committee, reviewed in detail, and plans then developed for incorporating the improved techniques within the transportation structures of the respective plants.

An operational analysis of track maintenance is an illustration of work being performed by a subcommittee. In this case the committee developed current practices, and costs, within each plant to lay ties, rails, and install switch stands. A standard operational analysis was then established, and this became the standard practice and procedure for the function. Application of standard operating practices has long been common in most fields of operation. The intent is to extend this same approach into all areas of transportation operations where it is considered to be practical.

Transportation cost controls have proven to be an excellent medium for establishing the meeting of minds of those engaged in transportation activities and for arousing an operating curiosity among the plants. Extensive use of costs, on a comparison basis, provides two salutary services for management:

1. It supplies each plant with detailed information about its transportation operations, because it centralizes by cost control transportation functions that normally are decentralized in their organizational make-up, thereby not making themselves conducive to analysis.

2. It indicates to each plant through comparison, those areas of low cost performance in existence, thereby encouraging personal observation and analysis of competitive operations.

The natural conclusions arrived at, when transportation costs are higher in one location than observed elsewhere, are to seek improved practices through changes in methods. Transportation cost controls, as an incentive for this accomplishment, have more than justified the efforts expended to accumulate and appraise data necessary for attaining objectives.

OTHER TRANSPORTATION CONTROLS

Transportation efficiencies can also be realized from other directions than those secured by cost awareness. Central operations also utilizes the following:

1. Regulation of the amount of materials carried under load for production requirements.

2. Provision for transportation services to operating units on a scheduled basis.

3. Supply of the proper type equipment used for shipping product, in a satisfactory condition, and at the time required.

4. Planned direction in which transportation responsibilities should work to obtain method improvements.

Transportation controls to accomplish the aforementioned objectives are in daily use for the purpose of more effectively realizing the complete purposes of material handling. The writer would like to review these methods individually and to report how they are applied.

A. Car burden control—Technological developments experienced with an expanding economy have resulted in industry steadily increasing its production capacities. Many instances of such expansion have been experienced within restricted plant sites.

On a tangent, there has existed in the minds of segments of operating responsibilities the belief that insured continuity of production can be guaranteed only when large amounts of raw materials are constantly backed up against a producing unit. "Sufficient materials on hand" too often has meant saturation at points of absorption.

Restricted operating areas, and high material burdens were one of the first phases of transportation studied by central operations, and for which, transportation controls were developed. Since each one hundred railroad cars of material "taken off wheels" releases the use of approximately a mile of track (thereby improving movement flow and reducing mill congestion), car burden controls were developed and installed. The desired results have been attained.

To institute car burden controls, it is necessary to first develop with each plant such basic facts as track and bin storage capacities, material consumption rates, frequency of switching, and related operating considerations.

There are then developed "burden bogeys," i.e., the number of carloads of each material that we believe may properly be kept "on wheels" within a plant at any one time. Performance measurements kept daily, establish performances based upon the standard carloads allowed versus the actual number of cars on hand.

This information is used by the raw material and traffic divisions and by central operations transportation to provide a continuous check of materials "on wheels" indicating those commodities in excess of standard and where they are located.

Use of this control has been a strong contributing factor toward helping reduce plant car burdens these past three years, at the same time that operating and material consumption rates have been on the increase.

B. Control by scheduling material movements—Adequately moving all materials necessary to a producing unit, at the instant the operator demanded such service, would require transportation facilities in the form of an industrial accordion possessing expanding-contracting facilities that would handle unpredictable peak requirements and at the same time economically operate under low service requirements. It cannot be done that easily, since the allowance of

unrestricted service would only result in long periods of nonproductive equipment utilization undoubtedly necessitating excessive service charges in order to survive in business.

There does exist, however, between the points of excessive demands with their resultant high costs and low cost intermittent service requirements, an area that through use of co-ordinated development can bring demands and service into balance.

It is the experience of our plants that continuous and effective service movement can be attained through scheduling of material movements.

Developing scheduled material movements at a particular plant, uses the following methods for installation. Each mill track and truck loading area is evaluated as to length and capacity, the best operating schedules of the mills, and the ability of a loading unit to economically accumulate materials in advance of loading are assembled for evaluation.

These data are analyzed with full consideration for turn changes, and the actual starting and quitting times of the working mill units.

Fundamental desire is to establish a scheduled notification time which will be used in requesting service for each track or for each truck.

Switching and trucking performances indicate the percentage of requested service attained on schedule. Twenty-four hour reports issued at the plant crystallize where "fall-downs" occurred as well as supplying reasons for failures.

Most significant result obtained from use of this practice for scheduling requests for switching and/or truck services has been improved communication among the responsibilities requesting service and those providing it. Mutual understanding of the problem and the resultant performance increases were proven the feasibility of maintaining such a system.

C. Car forecasting control—The development of an adequate supply of empty rolling stock necessary for moving production in central operations is the purpose of car forecasting. In co-operation with various staff responsibilities, the plants are provided with preliminary car requirements up to a week in advance of shipping, thereby providing them with the opportunity to anticipate forthcoming needs of industry and thus prepare plans that will enable the supply of equipment to be maintained on a continuous basis to meet demands.

Car forecasting controls are developed from an estimate of planned shipments for the period—Sunday through Saturday; operating and loading turns scheduled for each day of the particular week; and the anticipated receipts of scrap and other such items that represent potential empty cars.

This total data is converted to equivalent carloads for various types of railroad equipment (such as, wood floor gondolas and boxcars). The forecasted numbers of empty cars that will be required to handle shipments are then ordered by the following types:

a. Regular gondolas.
b. Wood floor gondolas.
c. Sixty-five foot gondolas.
d. Single-door boxcars.
e. Double-door boxcars.
f. Flat cars.

The car forecast estimates by plant the total quantity of every type car needed for each day and for the week.

The weekly forecast is supplemented by twenty-four hour reports that recognize individual plant differences that may have been caused by unpredictable operating factors such as mill breakdowns.

Each carrier, the individual plants and the traffic division are furnished copies of the forecast. Following completion of the work week, there is supplied a report of empty car performance.

Empty car quality standards have been established in order that all parties participating in the use of the forecast would have a mutual understanding as to the quality of cars that could be used at the plants. Also developed and supplied to these same responsibilities have been data that measured the excess costs experienced by industry when particular types of cars were not available to meet demands.

Car forecasting has provided fuller communication of industry needs to each of the carriers by supplying them with a more complete understanding of plant needs, and the importance of stabilized performances necessary to a manufacturer if it is going to be able to realize the most economical shipping costs available.

Efficiently performed car forecasting substantially assists toward attainment of effective practices in loading and shipping, a maximum performance from loading turns utilized, and reduction in the number of hours necessary to perform loading operations.

EFFECTS OF TRANSPORTATION CONTROLS—NEW METHODS

There have been discussed forms of transportation controls utilized to realize balanced car burdens at a plant, the maintenance of controlled service through requests for scheduled rail and truck services, and the balancing of shipping requirements to the availability of rolling stock with car forecasting.

Continuous use of the types of transportation controls here reviewed have lead to a constant search for lower costs and better methods.

SUMMARY

Transportation controls in steelmaking have directed the transportation responsibilities of our company into areas of cost governing such functions as plant-owned track maintenance, utilization of industry locomotives and blast furnace iron ladle operating costs. They have resulted in improvement to many material handling methods, and to an extended use of special equipment. These controls have become preeminent as tools by which management plans, develops and installs dependable and efficient operating techniques that supply it with lowest cost transportation service. There remains much work to be done to get transportation control out of the field of pseudo-science. The techniques stated in this paper are merely first steps in the application of management methods to a field of operation, in many instances too long neglected.

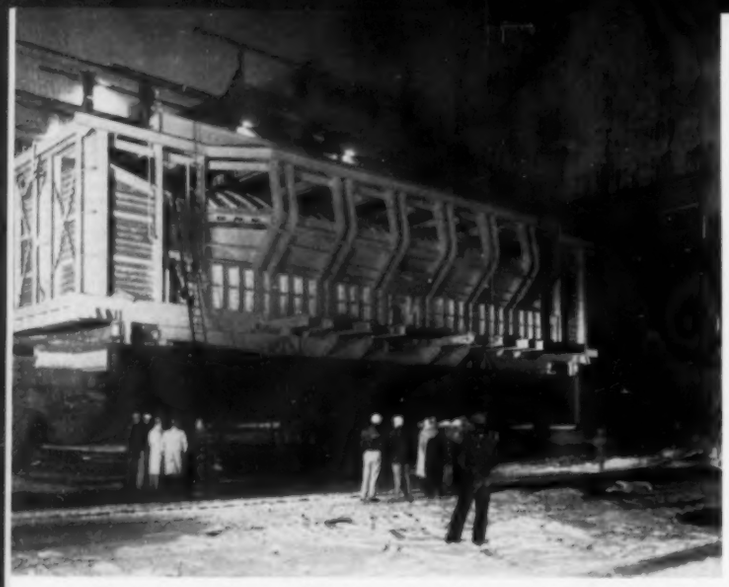


Figure 1 — Some 1850 tons of brick and steel, comprising a complete open hearth furnace, stand outside the open hearth building at U. S. Steel's Geneva works ready to be moved into place in the line of 10 furnaces. This is the first open hearth furnace ever to be completely fabricated, erected, and bricked outside a shop and moved into place as a complete unit.

Figure 2 — Engineers check last minute details as a diesel locomotive hooks on to the ingot cars carrying the big open hearth furnace. Because of the overhand of the end of the furnace, two handle cars, loaded with 75 tons of dead weight, preceded the engine which pushed the big structure to its cross transfer foundation 900 ft inside the open hearth shop.

Unique Procedure Helps Geneva Speed Increase in Steel Capacity

Geneva works has pioneered in the rebuilding of open hearth furnaces away from the furnace site . . . . not only has the steel been prefabricated as was done in the first unit, but the brickwork has been completed outside as well . . . . substantial savings in downtime are accomplished . . . .

▲FIRST phase of the program announced in 1955 to increase steelmaking capacity by 20 per cent at Geneva Works, Provo, Utah, has been completed and work is well under way on the second phase of this facility of U. S. Steel's Columbia-Geneva Steel Division.

The initial phase was featured by use of a process unique in the steel industry, involving "prefabrication" of complete open hearth furnaces outside the open hearth shop and moving them into place as a complete package—thus accomplishing substantial savings in downtime. Eight of the 10 Geneva open hearths were rebuilt and enlarged to 300-ton capacity in this fashion, and in the last of these, even the brickwork was completed outside. The other two furnaces were rebuilt in conventional fashion earlier.

The second phase, now being carried on, involves addition of auxiliary equipment such as cranes and ladles to handle the increased heats of steel from the furnaces.

The entire program, which will raise the plant's rated steelmaking capacity to 2,262,000 tons a year, will be completed late in 1957.

Geneva Works engineers developed and perfected the prefabrication and package move-in method for rebuilding and enlarging the open hearths. In the case of seven of the furnaces, the steelwork was completed outside the shop; the furnaces then were placed in position; and the brickwork then installed.

In the case of the last of the furnaces—No. 6, the engineers and maintenance division personnel carried on a unique and highly successful experiment. They built the entire furnace outside the shop, complete with

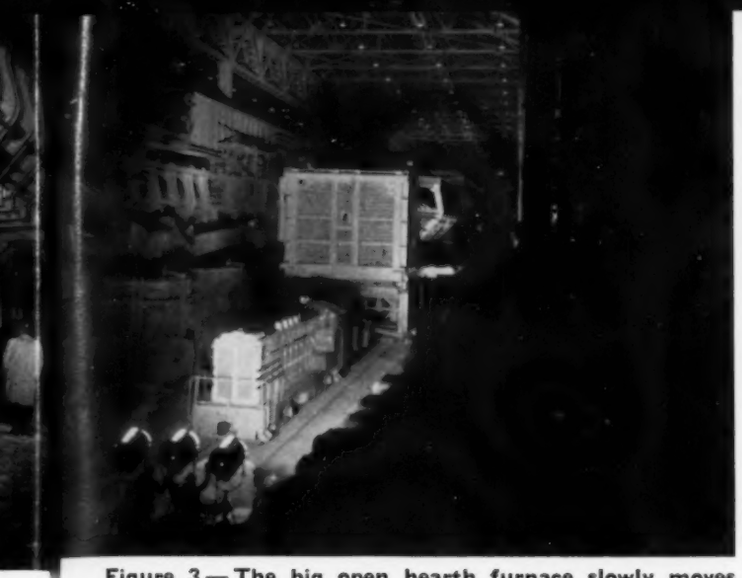


Figure 3 — The big open hearth furnace slowly moves down the pit side of Geneva works open hearth shop. Carried on two sets of ingot buggies, the big 1850-ton structure was pushed into position deep inside the shop. In the left foreground can be seen a similar furnace which earlier was enlarged to 300-ton size.

Figure 4 — A hole, 100 ft across, in the Geneva open hearth charging floor stands ready for the big furnace. With the furnace carefully alined for cross transfer, the 120-ton diesel switch locomotive was uncoupled and moved out of the shop. Special push-button controls on the big red and white engine permitted it to "crawl" smoothly at a snail's speed under maximum power.

33 carloads of refractory brick, then moved the 1850-ton furnace, 900 ft into a cross transfer position. Total transit time for the move-in was 78 min.

Downtime on No. 6 furnace was only 11 days, as compared with customary periods running as high as 30 days. Normal downtime in the Geneva shop on the previous rebuilds using the prefabrication method has been around 16 days, and on one of the furnaces built using the conventional method, a total of 23 days elapsed before the furnace was ready to produce.

To make the move into the shop as simple as possible, the furnace was constructed on six ingot mold cars mounted on three sets of track. On previous move-ins, only four cars and two sets of track were necessary, but the additional weight of the refractory lining made it necessary to add the third set of cars and track.

An erection platform was installed on the six cars. It consisted of specially designed beams installed at right angles to the track. Roller assemblies were then installed on the top of these beams so that the furnace could be rolled into place when it reached location in the shop. Rigid frame base plates were mounted on the rollers and the furnace was constructed as on the other prefabricated rebuilds.

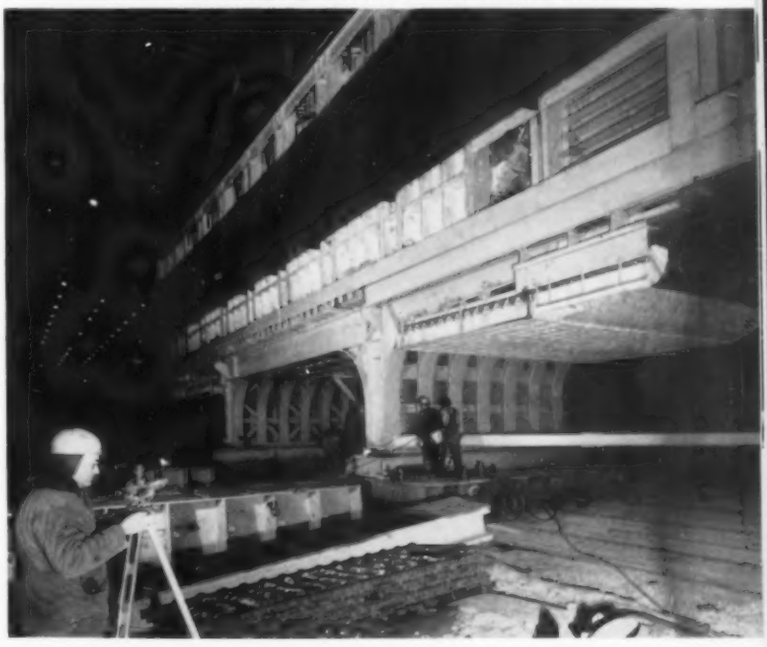
With brickwork to be installed on the furnace ends, steel girders and attaching members were designed to provide support for the cantilever load and thus eliminate any deflection in the structure of the furnace. Tie rod bracings across the ends of the furnace roof, on the vertical face of the furnace and vertically on the furnace sides were also installed to prevent any movement or sway in these areas during the transfer of the furnace.

Winter weather conditions made it necessary to protect refractory materials from freezing, so special heating units were installed in the furnace structure as actual brickwork commenced on the furnace.

The three sets of track were extended from the erection site 900 ft along the open hearth pit to the furnace location. Approximately three feet of dolomite fill was placed under the tracks to insure a uniform bearing surface for the track ties. A heavily reinforced concrete pad approximately four feet thick was previously poured in the pit cross transfer area opposite No. 6 furnace.

This was the site where the furnace would be transferred from the cars to the foundation columns which support it during operation. Two structural steel transfer bridges were fabricated to carry the furnace across the space between the erection platform on the cars

Figure 5 — Engineer checks for any deflection or tilt in the big furnace as it is lined up to be cross-transferred onto its foundation columns. Under the slag pocket brickwork, can be seen three of the ingot buggies upon which the furnace rests. These were used as a base for the erection platform. The heavy black beam across the front of the furnace was used to hold up the cantilever ends of the furnace. When the furnace was in place on the foundation columns, this beam was removed and the charging doors added to the structure.



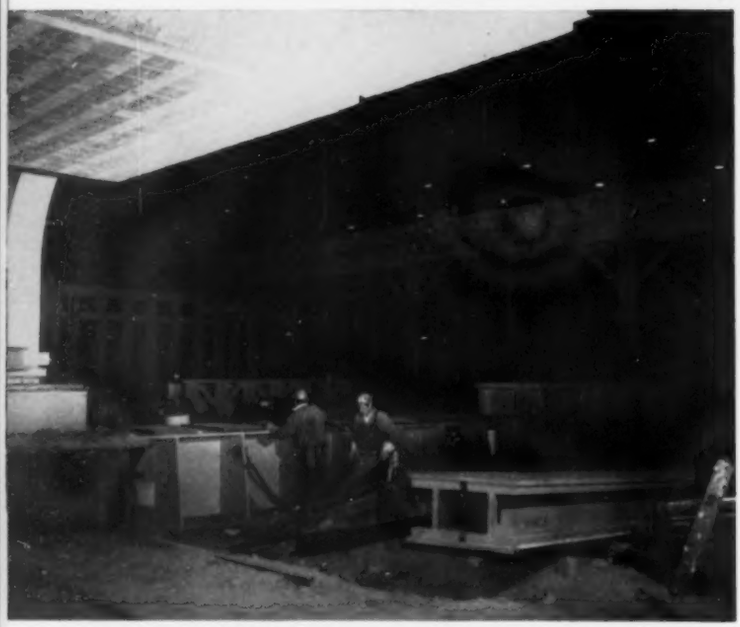


Figure 6 — With the furnace alined, ready to be moved into final position in the shop, workmen prepare the transfer table for rolling the furnace. In the foreground is one of the top sections of a structural steel bridge used to carry the furnace from the ingot buggies to the foundation stub columns seen in the background.

and the foundation columns. These bridges consisted of two sets of heavy structural steel pedestals, beams and plates on top smooth enough for the rollers which carried the furnace into place.

When all was ready and the old furnace had been dismantled and removed (this took approximately six days), one of Geneva's 120-ton diesel switch engines was coupled to the middle mold car bearing the furnace. Because of the hangover of the end of the furnace structure, a train of two handle cars was necessary. The couplers of the locomotive, the handle cars, and the ingot mold cars were blocked in extended position to eliminate any possible slack, should the locomotive change from a pushing to a braking action.

Figure 7 — Workmen connect the pulleys and blocks and tackles to a double drum hoisting engine used to pull the furnace into place from the ingot buggies. In the foreground can be seen the lower structural sections of the bridges with steel shims used to make the top section exactly level with the underside of the furnace and the top of the foundation stub columns.

Figure 8 — Workmen place sets of rollers on the structural steel bridges. The furnace was rolled from the ingot buggies to the foundation columns on these rollers in less than 30 min. Within the structural bridges, heavy jacks were installed to level the top section of the bridges if necessary; however they were not needed.

The moving operation was held to an extremely low speed by means of special rheostat push button controls, and the furnace moved into position opposite the foundations of No. 6 furnace. Upon arrival at the cross transfer station, the locomotive and handle cars were uncoupled and removed from the pit area. Geneva electricians, not taking any chances, had rigged the locomotive with a rheostat controls which assured smooth movement at extremely low speed.

Once on the cross transfer site, the furnace was accurately alined and the transfer bridge assemblies positioned in perfect alinement with roller plates on the foundation columns on one side, and the furnace rollers on the other.

A double drum hoisting engine driving through a torque converter had been installed and the cable from each drum reeved to provide a 12 part line to pull the structure on the rollers. Another four part line was used for a holdback for braking.

The cross transfer speed of the furnace approximated one fpm. Instrument checks were taken during the transfer, just as they had been taken during the move-in, so that any deflections could be noted. No remedial measures were necessary.

In approximately 20 minutes the structure had been moved to position on the supporting columns and the final positions of the furnace were made. Furnace ends were welded into place on end columns. Roller protection at the rigid frames consisting of box-like assemblies were welded into place.

The final phase of the rebuild consisted of making the tie-ins between the furnace and existing facilities (pip-

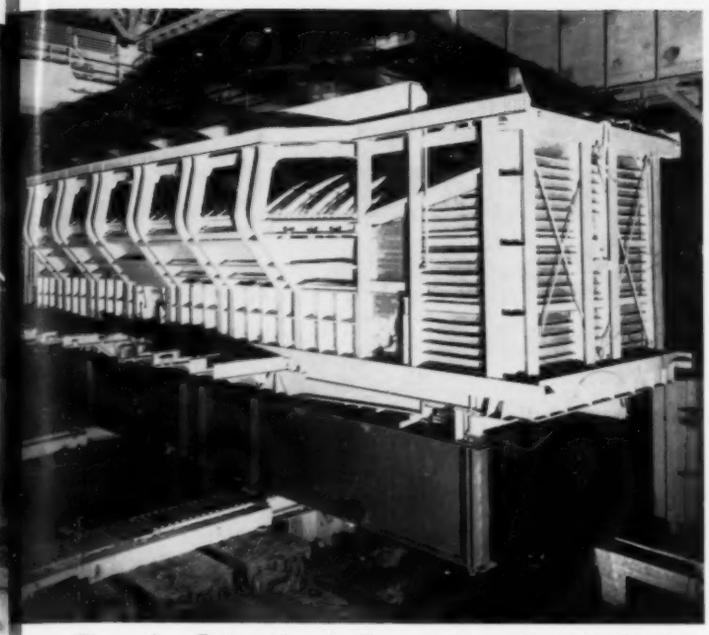


Figure 9 — Better than half way into position, the big furnace has left the ingot buggies and rests midway between the ingot buggies and the foundation stub columns. The long black beam running across the bottom of the furnace was used to hold up the cantilever ends of the furnace until it was in position on the end columns, then it was removed.

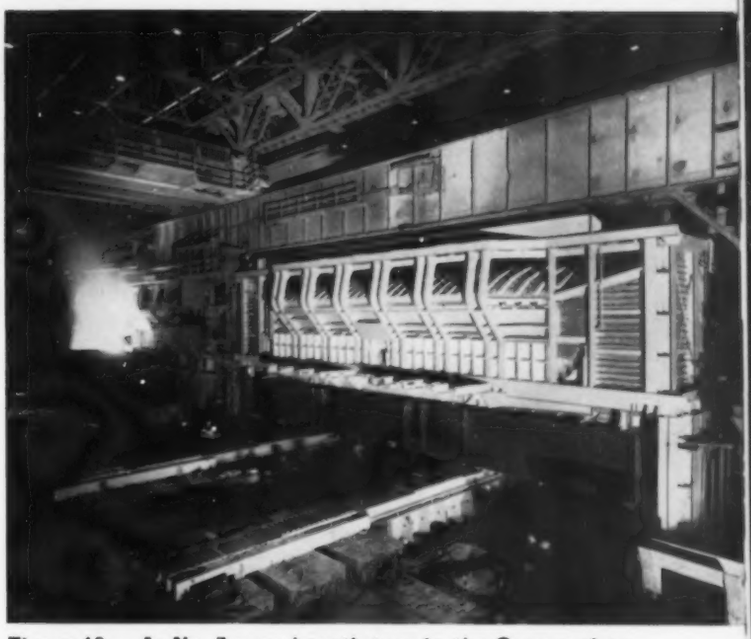


Figure 10 — As No. 5 open hearth taps in the Geneva shop, workmen complete the move-in on the No. 6 furnace. The new furnace was set in place with only 11 days' downtime. A total of 78 min transit time was needed to move the 1850-ton furnace from its position outside the shop to its final foundations.

ing, structural, and electrical) and sealing the slag pockets and checker chambers.

The furnace was now complete and the fuel turned on approximately 11 days after tapping the last heat from the old furnace.

Fabrication and erection of the steel framework was handled by U. S. Steel's American Bridge Division. The Consolidated Western Steel Division of the Corporation acted as a subcontractor for part of the work, including removal of some of the old furnace.

With the work of enlarging the furnaces in Geneva's shop complete, the addition of auxiliary equipment in the shop, the second phase in the program of increased capacity, was started immediately. Bigger ladles to handle the increased sized heats are beginning to arrive at the plant, larger charging boxes are in use, and added crane facilities to handle the heavier loads of steel are being installed.

Three other existing 300-ton pit cranes will be rebuilt and enlarged to 450-ton capacity, and the entire program is expected to be completed by late 1957. Geneva's annual rated capacity at that time will become 2,262,000 tons, as against the former figure of 1,879,000 tons.

Revised and rearranged collection of articles which appeared in the Iron and Steel Engineer between 1943 and 1950 . . . a book for rolling mill men and for anyone interested in rolling mills and roll design . . . written from a practical viewpoint by one who has had considerable experience in the art of roll design.

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Integrated River Material Handling System Features New Aluminum Plant

▲ONE of the nation's youngest aluminum producers has chosen river transportation for fast, economical handling of a major share of its bulk raw materials.

The Olin Revere Metals Corp., recently formed by Olin Mathieson Chemical Corp. and Revere Copper and Brass, Inc., has approved the awarding of contracts to Dravo Corp., Pittsburgh, for the construction of an integrated system which will speed the conversion of bauxite into aluminum. F. H. McGraw and Co., New York, is the general contractor for the plant.

Components of the system are:

A 935-ft ship dock and a modern bulk materials unloader, to be installed at Olin Revere's new bauxite refining plant at Burnside, La.

A 200-ft, 4200-hp towboat and two specially designed 15-barge fleets (Dravo is furnishing 24 of these barges) which will be used to transport alumina from Burnside to Olin's aluminum plant at Omal, Ohio, near Powhatan Point, Ohio.

Bauxite from Dutch Guiana will be brought 170 miles up the Mississippi River by ocean-going ships to Burnside. There it will be unloaded and converted into alumina. The alumina will be transhipped by river barge to Omal.

A major feature of the dock and unloader is their potential for varied usage. The dock, one of the few of its type in the lower Mississippi River area, will consist of 12 sheet steel pile cells, set 500 ft out from the levee. Ships can be moored on the river side of the dock, barges on the levee side. The dock will accommodate ships with drafts up to 40 ft.

Running the length of the dock will be a steel girder bridge, paved with concrete and supporting the track on which the unloader will operate. The two rails of the unloader will be 30-ft apart, leaving ample room for a truck road and a conveyor belt system running parallel to each other inside the unloader tracks.

Thus, bulk cargo may be unloaded from ship to barge, from ship to truck, from barge to ship, from barge to truck, from ship to conveyor belt, and from barge to conveyor belt. A future belt system will also permit loading out bulk materials from shore to ship or barge.

The unloader, which will be electrically-powered, will have a free-digging rate of 1000 tons per hr for all types of bulk material. However, it will be used principally for unloading bauxite. The dock has been designed to provide for additional unloaders.

A belt-type ship and barge loader will be added at a later date. This loader will be served by the conveyor belt along the land side of the dock.

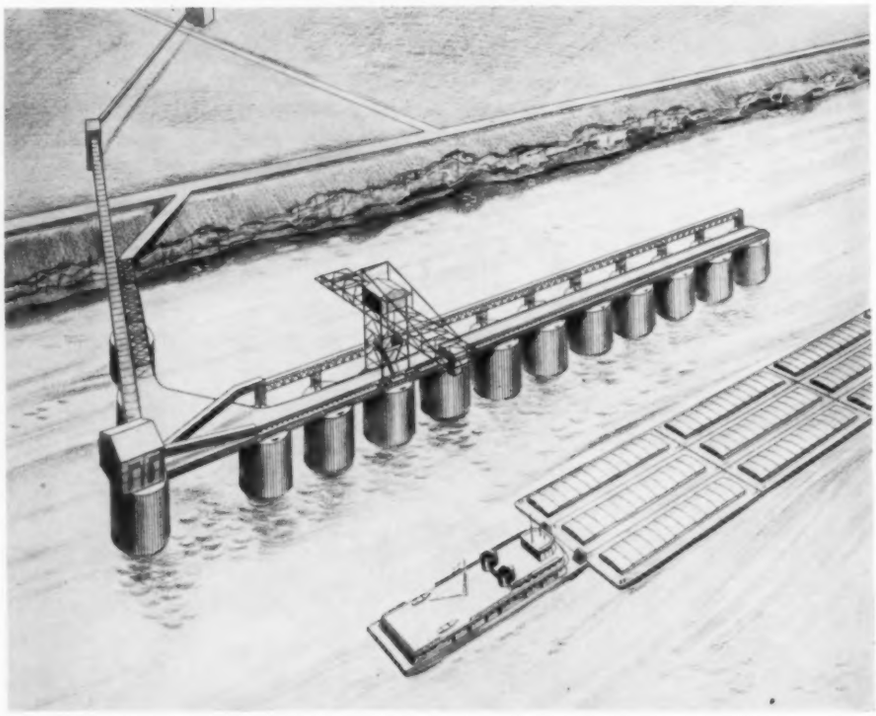
Two 44-ft diam cells and three steel bents will support the truck road and conveyor belt from the dock to the levee. The belt system will be supplied by the Link-Belt Co. Because the level of the Mississippi River at Burnside varies from 25 to 35 ft, the top of the dock will be 37 ft above the low water level.

The new 200-ft Olin towboat will be one of the largest on the inland waterways. It will be powered by twin Nordberg diesel engines capable of delivering a combined 4200 hp.

Featuring many design innovations developed by Dravo in model basin tests both in the United States and abroad, the towboat will have two stainless steel, five-bladed propellers 10 ft in diam, housed in streamlined cast steel Kort nozzles. The towboat will be equipped with a full complement of the most modern navigational aids.

Work already has begun on the dock to provide temporary unloading facilities during the first quarter of this year. Four of the 12 cells will be built and connected by temporary bridges for operation of a large crawler crane used for temporary unloading.

Figure 1 — Artist's conception of new ship dock and bauxite unloader to be constructed by Dravo Corp. at Burnside, La. for Olin Revere Metals Corp. Also shown is 4200-hp towboat and integrated tow which Dravo will build.



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Rod Mill in operation. All machinery, equipment and utilities installed by Rust personnel.

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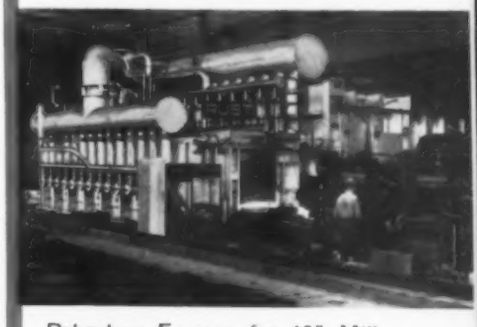
1. **DESIGN AND CONSTRUCTION** Building facilities for this combination merchant bar and rod mill were designed and constructed by The Rust Engineering Company The plant is completely new.
2. **MACHINERY INSTALLATION** All machinery, auxiliary equipment and utilities were installed by The Rust Engineering Company.
3. **ELECTRICAL INSTALLATION** Electrical work was handled by Allegheny Industrial Electrical Company, Inc.
4. **REHEATING FURNACE** The double-fired, zone controlled, recuperative, continuous reheating furnace was designed, built and installed by Rust Furnace Company.

This modern mill has a maximum speed of 5,000 feet per minute for rods, and a production rate of 50 to 70 tons per hour for merchant products. The mill produces rods, rounds, flats, angles, and light beams of various sizes.

Motor Room of new Mill. All electrical installations by Allegheny Industrial Electrical Co., Inc.



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LADLE CRANES REACH 500-TON SIZE

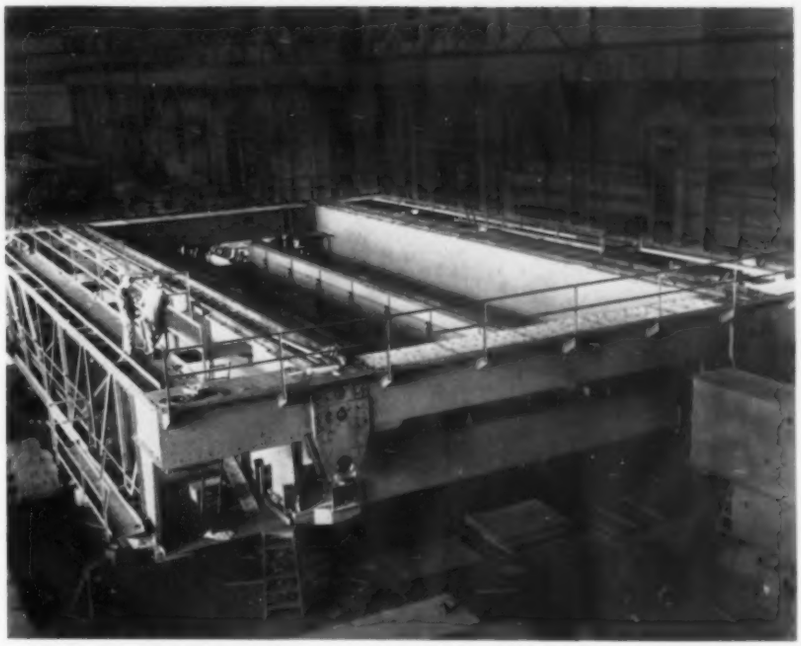

Figure 1 — Over-all view shows the crane's bridge, partially assembled.

▲ TO help meet the ever-increasing demand for steel, and the larger heats planned for the new open hearth shops, Morgan Engineering Co. recently held an open house at their plant in Alliance, Ohio, to show the first of three 500-ton ladle cranes scheduled to go to an eastern steel plant.

This crane is the largest ever built of its kind and will handle a ladle having an outside top diameter at top of 17 ft 0 in., bottom diameter of 13 ft 10 in., and height of 17 ft 3½ in. The ladle will hold 375 tons of hot metal with a minimum lining thickness.

Each of these cranes consists of four girders, span of 77 ft 0 in. (center to center of bridge trucks) and is driven by eleven electric motors, totaling 1658 horsepower. Each crane will have a 75/25-ton auxiliary trolley. The bridge and large trolley run on universal type trucks, each equipped with four wheels.

Total weight of crane including electric equipment, but not including ladle and hot metal, is 1,841,000 lb.

500-TON BRIDGE

Bridge details are as follows:

Bridge span 77 ft 0 in. with 2 ft-4 in. overhang, each end.
Length of bridge 68 ft 4 in. end to end of bumpers.
No load speed 380 fpm.
Full load speed 315 fpm.
Maximum wheel load 87,500 lb.
Bridge operates on four parallel runway rails, with each two rails running on 36-in. centers.

All bearings are anti-friction type.

The bridge is driven by four 135-hp motors with one motor located at each corner, and all motors are wired in parallel. Two motors on each side of the bridge, at parallel corners, are connected by a 4½-in. diam lineshaft. The other end of each motor is connected to a gear drive by a flexible coupling, which has two slow speed floating shafts connected to the trackwheel assemblies.

Each drive is of rugged construction, containing carburized spur gears in a housing of welded steel construction, and contains a motor pinion and gear having single helical cut teeth for quiet operation.

Each crane bridge has forty-eight 30-in. diam heat treated (carburized) trackheels. Tread of each

Figure 2 — Automatic and hand welding operations were used in fabrication of the main girder.

Figure 3 — View of the crane's main girder shows unique parallel trolley rails.

wheel was ground to a tolerance of ±0.005 in. Each two wheels are assembled on a common axle with the distance from center to center of wheels being 36 in.

The trucks are of a special design, each containing two double wheel assemblies and bored in center near top for an 8-in. diam equalizing pin, which runs right angle to the runway rails. Each wheel assembly is self-equalizing which is mandatory in order that all wheels bear on the runway rails at all times, as each runway rail is supported on its own building girder and is expected to have different degrees of deflection under load. Each truck, completely assembled with wheels, weighs approximately 20,000 lb. Maximum wheel load is 87,500 lb and maximum load at each axle is 175,000 lb.

Each wheel assembly can be removed from truck by jacking the crane a fraction of an inch, removing bolted end retainers and rolling the assembly onto a special constructed dolly.

The two main girders have top and bottom cover plate 40 in. wide x 2¼ in. thick. The web plates are 118½ in. wide x ¾ in. thick. There are two 175-lb rails on each girder spaced on 27-in. centers. The girders are of welded steel construction, all welds being made by the automatic submerged arc process. Total weight of each girder with rails is 115,000 lb. The two small girders have top and bottom cover plates 27 in. wide x 1 in. thick and web plates 70 in. wide x ⅜ in. thick. There is one 175-lb rail on each girder. Girders are of welded steel construction, and weight of each girder with rail is 34,000 lb. The end ties and equalizer beams are of welded steel construction. The weight of each end tie is 30,000 lb. Bridge height from top of runway rail to top of rails on girders is 11 ft 8½ in.

The total height of crane from top of runway rail to maximum height of trolley is 23 ft 7½ in. There are two main walkways—one on side of each girder and each having a total area of 636 sq ft. A portion of this area is used for electrical panels and resistor racks for bridge controls. A secondary walkway 2 ft 9 in. wide which runs length of bridge is provided above each main walkway to service the main trolley collectors. A repair platform of sufficient size is provided over the main walkway, for trolley repair and maintenance purposes.

500-TON LARGE TROLLEY

Details of trolley are as follows:

- Trolley span 34 ft 0 in., length with overhang is 47 ft 6 in.
- Width 30 ft 4 in.
- Height 11 ft 11 in.
- Hoist speed 10 fpm.
- No load speed 75 fpm—cross travel.
- Full load speed 50 fpm—cross travel.
- Maximum lift of ladle hooks before engaging limit switch is 56 ft 1 in.
- Maximum wheel load is 110,000 lb.
- 640,000-lb finish weight.

All bearings are anti-friction type. There are four 4-wheel trucks, with each two trucks running on two parallel rails on 27-in. centers on each bridge girder. Each truck consists of two wheel assemblies, two 30-in. diam wheels per assembly, and is in all respects constructed the same as the trucks for the bridge except the wheel center is 27 in. and truck wheel base is 5 ft 0 in.

The trolley is driven by two 65-hp motors wired in series, through two A-5 type drives. Eight wheels out of a total of sixteen are driven.

The hoist consists of two 87-in. pitch diameter x 15 ft-6¾ in. long welded steel rope drums, geared together. Each drum weighs 50,000 lb. There are seventy-six parts of 1⅜-in. diam hemp center steel wire ropes.

These trolleys are of interlocked drum design, each drum being driven by its own 360-hp motor with a ratchet in each gear train. The rachets prevent stresses in the gear trains due to the hoist brakes setting on one motor ahead of the other hoisting motor, or in cases where one motor would become energized ahead of the other.

Each hoist gear train is composed of one 360-hp motor, two magnetic brakes and a 31.250-in. center worm gear set with a ratchet mounted on the worm gear shaft which, in turn, drives the drum pinion meshing with the drum gear. The drum gears are interlocked to insure uniform hoisting speed at all times.

Each worm gear set is lubricated by oil sprayed on the top of worm in addition to the worm gear dipping in a bath of oil.

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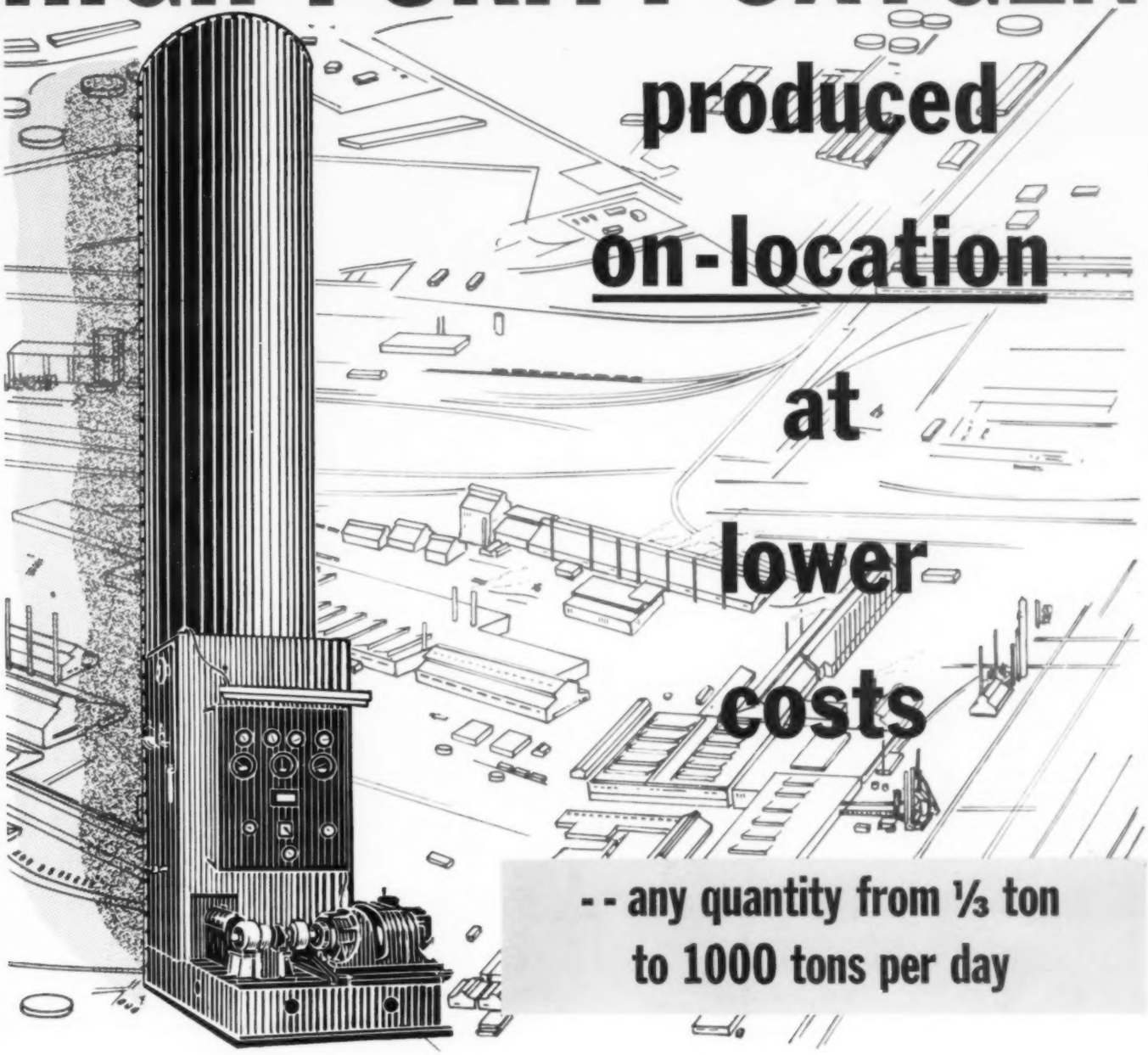

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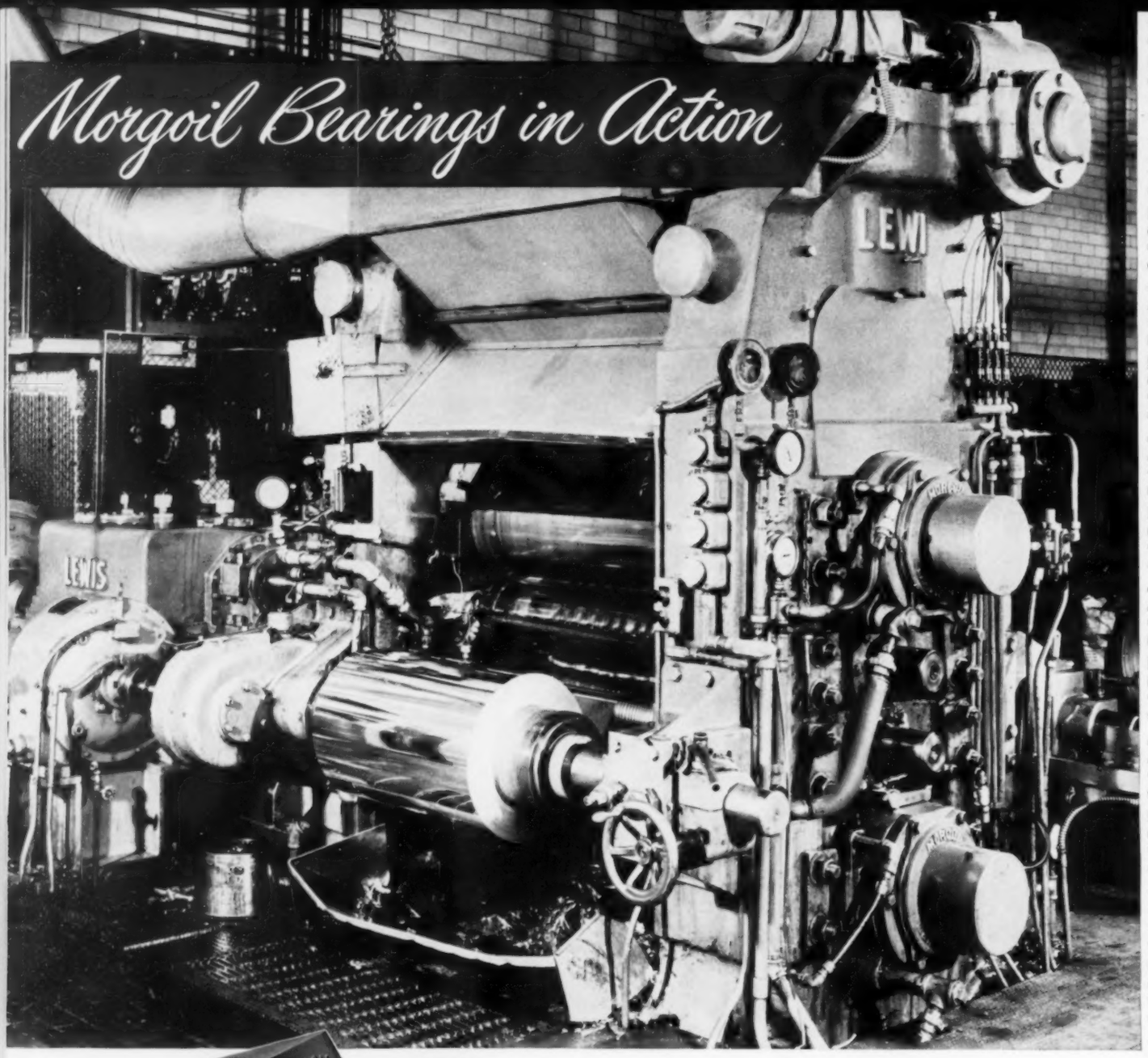

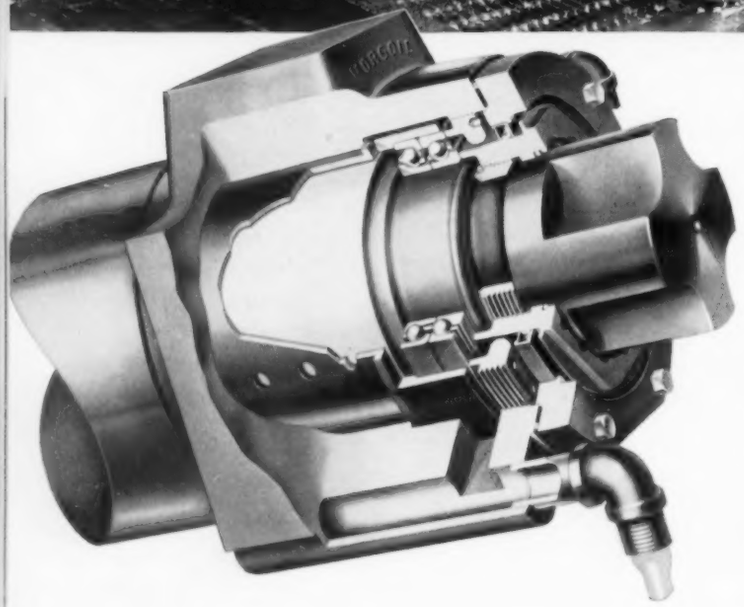

The 18″-72″ MORGOILS on the 9″ and 21″ x 44″ Aluminum Foil Mill at Cochran Foil Co. pictured above make it easier to produce a quality product at high speed. Foil as thin as .00025 of an inch is rolled at speeds approaching 4000 feet per minute on MORGOIL-equipped mills. MORGOIL BEARINGS give you freedom from wear and fatigue and permit operation at high speeds with remarkable long bearing life.

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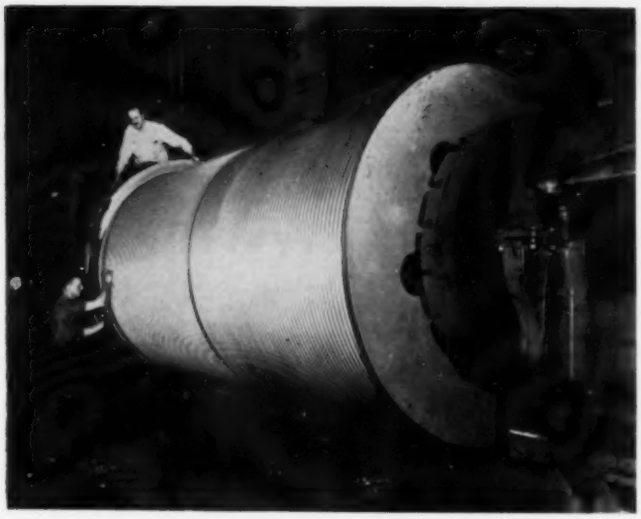

Figure 4 — Two main hoist drums were fabricated from structural plates and welded.

Figure 5 — Workmen are riveting plate sections of one of the two 250-ton hooks.

Means are provided to remove and replace the inside wheel assemblies through a trap door located in the center of each end tie.

The trolley frame, due to its large size, cannot be shipped as an integral unit like all other ladle crane trolley frames of smaller capacity. It was, therefore, designed and built so that it can be disassembled for shipping. The trolley frame will be assembled in place on the bridge after the bridge is erected in the open hearth building. The trolley frame will be made into an integral unit after assembly by field welding.

The large trolley frame, without mechanical and electrical components, weighs 138,000 lb.

The main trolley girder section is:

Top cover plate 28 in. wide x 2 in. thick.
Bottom cover plate 26 in. wide x 1½ in. thick.
Web plates 53½ in. wide x ¾ in. thick.

The lifting beam for the two large ladle hooks is 9 ft 9 in. high x 27 ft 4 in. long x 7 ft 5 in. wide and weighs 54,000 lb. The beam is made of welded steel construction. The two ladle hooks when assembled in the lift beam are on 19 ft-0 in. centers.

Each ladle hook is 17 ft 5 in. long x 7 ft 3 in. wide x 12½ in. thick and is made up of four ⅞-in. thick and nine 1-in. thick laminated plates held together by 1¼-in. diam rivets in body and by welding on outside edges in accordance with accepted standards. The two hooks have a combined weight of 68,000 lb.

75/25-TON SMALL TROLLEYS

Details of trolley are as follows:

Trolley span 12 ft 3 in., wheel base 14 ft 3 in.
Over-all length 17 ft 11 in. and width 14 ft 10½ in.
110,000 lb finish weight.
Trolley frame integral welded steel construction.
All bearings of anti-friction type.

The main hoist, 75-ton capacity, consists of one 48-in. pitch diameter x 9 ft 7 in. long body welded steel drum, connected to a 135-hp motor through a triple spur gear reduction. There are twelve parts of 1⅛-in. diam steel wire rope with the hook traveling at a full load speed of 22.3 fpm. Total lift is 75 ft 0 in. There are two magnetic brakes, one connected to motor and one to high-speed pinion shaft.

The auxiliary hoist, 25-ton capacity, consists of one 26¼-in. pitch diameter x 9 ft 11½-in. long body welded steel drum connected to a 100-hp motor through double reduction spur gear drive. There are eight parts of ⅞-in. diam steel rope with the hook traveling at a full load speed of 46 fpm. Total lift is 78 ft 0 in. One magnetic brake is attached to motor.

Two of the four 24-in. diam rolled steel carburized wheels of the trolley are driven by a 33-hp motor through a reduction spur gear drive at a full load speed of 133 fpm.

CAGE

The cage which houses the electrical control and auto-pour equipment and crane operator is 46 ft 8 in. deep from top of runway rail and contains five decks.

Outside stairs and walkways are provided on the cage running from the operator's compartment on the first deck to each succeeding deck and ending at the walkway on the bridge.

A removable side is provided on each of the four upper decks for the installation and replacement of electrical equipment.

The complete cage contains approximately 31,300 cu ft, or about three times more than an average five-room house.

SUMMARY

The crane throughout is of welded steel construction, with automatic submerged arc welding being performed where practicable. Welded gear drive housings, trucks, trolley frames, etc., were stress relieved in the new 20-ft x 15-ft x 52-ft car-bottom stress relieving furnace and cleaned with shotblast equipment.

The crane will be reeved with 6660 linear ft of 1⅜-in. steel wire rope, 1200 linear ft of 1⅛-in. rope, and 765 linear ft of ⅞-in. diam rope, which totals to 8625 linear ft, or 1⅔ miles of wire rope.

The rope used is 6 x 37 purple strand hemp center.

Approximately 10,000 engineering man-hours were expended to design and make detail drawings. Between twenty and twenty-five railroad cars will be required to ship the crane after dismantling in the shop.

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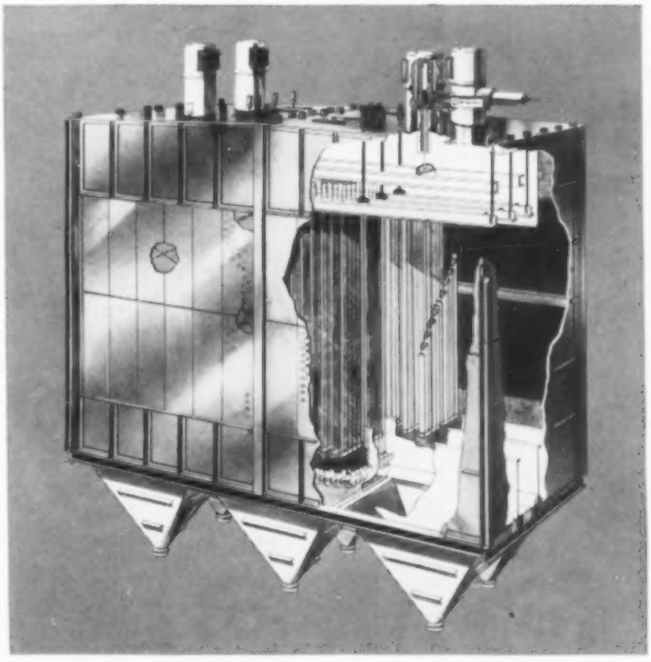
Koppers has over 75 years' experience in industrial gas cleaning. In addition, Koppers maintains extensive research facilities at Verona, Pa., and Baltimore, Md. Manufacturing facilities at Baltimore produce a complete line of gas cleaning equipment for every size and type of plant.

You can put all of this experience and equipment to work solving your gas cleaning problem. Just write KOPPERS COMPANY, INC., Metal Products Division, Industrial Gas Cleaning Dept., 8303 Scott Street, Baltimore 3, Maryland.

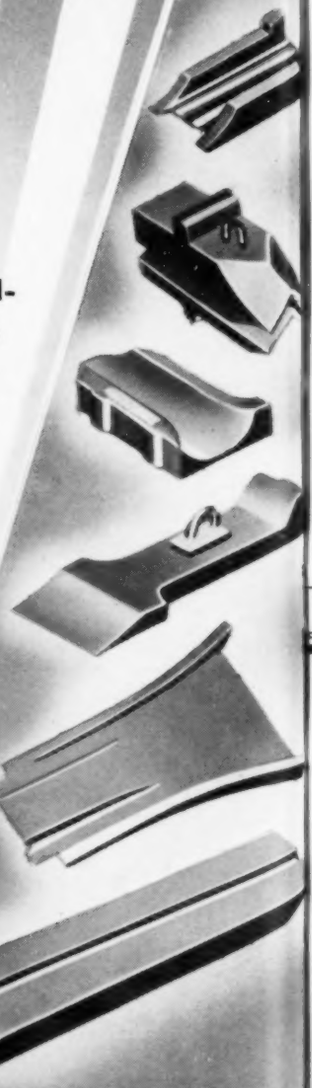


Cutaway photo of a Koppers electrostatic precipitator shows shell, vibrators, and collecting and discharge electrodes. The actual design and arrangement of elements vary widely because Koppers electrostatic precipitators are custom-designed to fit the requirements of each particular application.

TRANTINYL GUIDES THE STEEL INDUSTRY

"TRANTINYL" offers a quarter-century of metallurgical experience. "TRANTINYL" patented alloys were developed to function in specific operations where guides are required to resist wear and abrasion. Users of "TRANTINYL" alloys are astounded at the tonnage rolled over one set of guides.

Join the many satisfied users of "TRANTINYL."



ROLLING MILLS:
bar, hoop, strip, shape mill guides; and rollers.

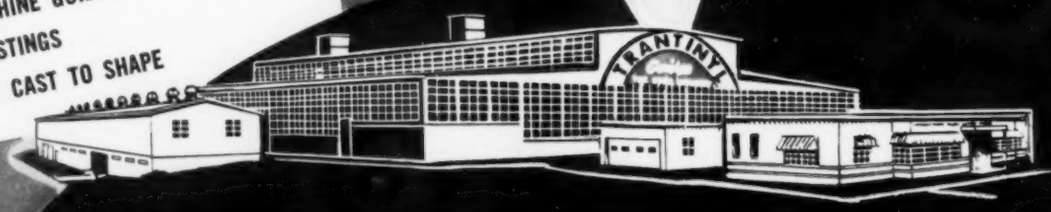
SEAMLESS TUBE MILLS:
guide shoes, rolling mill plugs and rolls, piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS

"TRANTINYL No. 1" CAST TO SHAPE



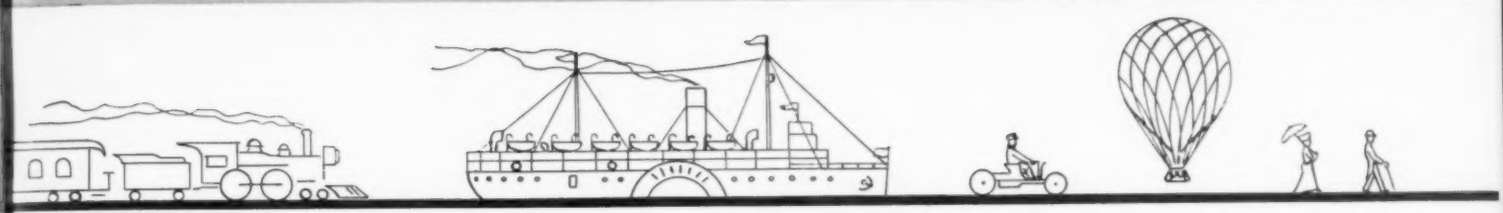
Youngstown Alloy Casting Corporation

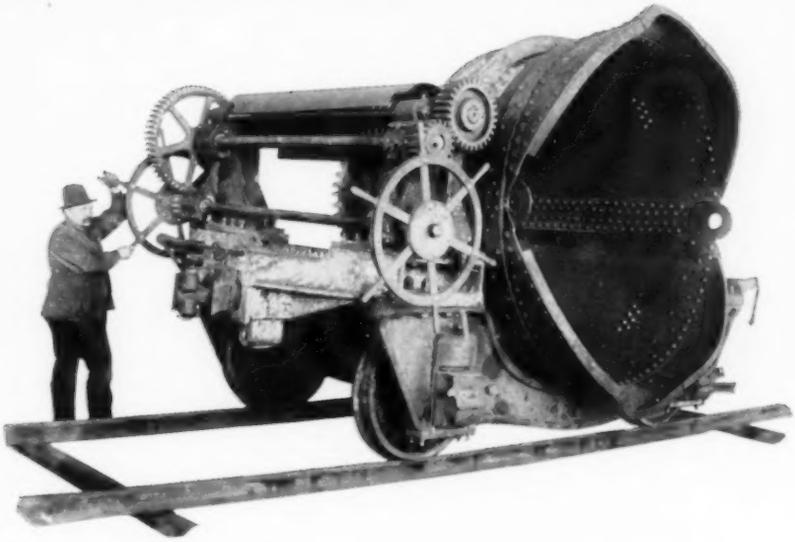
Youngstown, Ohio

1902 – 25 tons per open hearth heat

1957 – 550 tons per open hearth heat

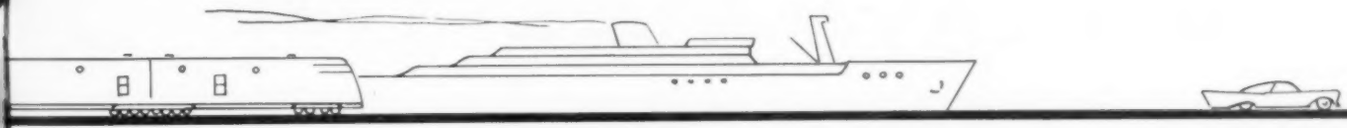
POLLOCK FEEDS HUNGRY OPEN HEARTHS

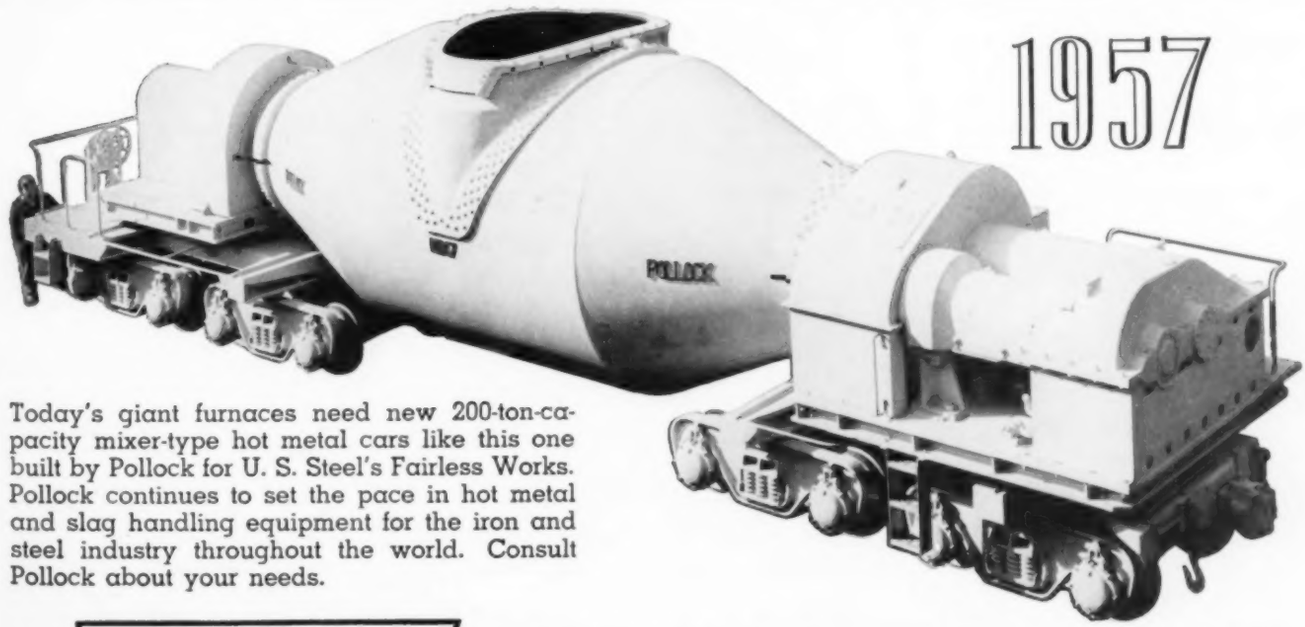




1902

Pigs went to market faster after Pollock designed and built this first 20-ton hot metal car. It was the first of thousands of hot metal cars built by Pollock.





1957

Today's giant furnaces need new 200-ton-capacity mixer-type hot metal cars like this one built by Pollock for U. S. Steel's Fairless Works. Pollock continues to set the pace in hot metal and slag handling equipment for the iron and steel industry throughout the world. Consult Pollock about your needs.

POLLOCK
SINCE 1863

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN, OHIO

STEEL PLATE CONSTRUCTION • ENGINEERS • FABRICATORS • ERECTORS

BLAST FURNACES • HOT METAL CARS AND LADLES • CINDER AND SLAG CARS • INGOT MOULD CARS • CHARGING BOX CARS • WELDED OPEN HEARTH LADLES

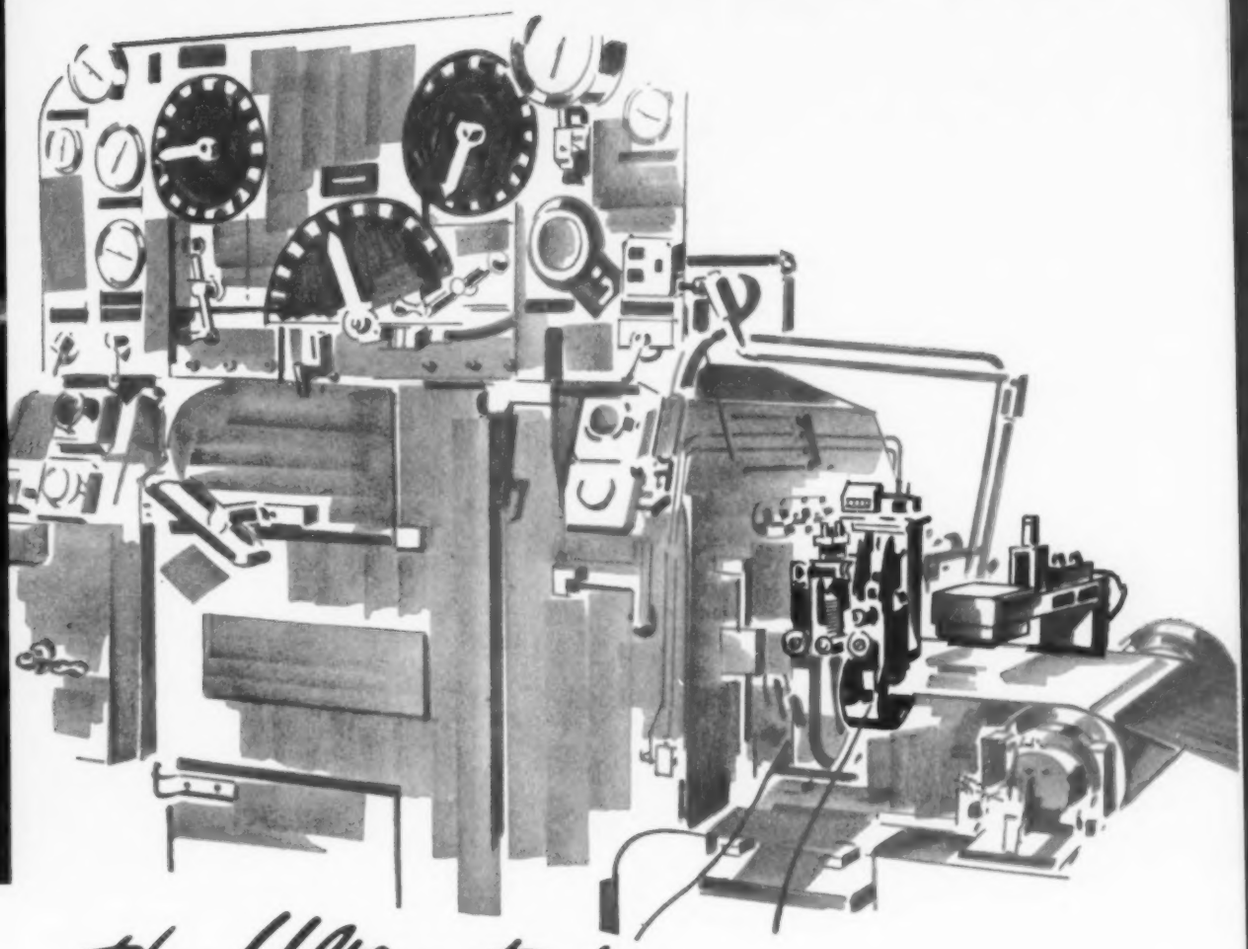
MAINTAIN MATCHLESS QUALITY

with PRATT & WHITNEY

THE X-RAY GAGES and CONTROL UNITS This is a reversing-type mill with duplicate P&W X-Ray Gages on each side. Giving continuous, extremely accurate readings, the gages are non-contacting, cannot mar the most highly finished surfaces. When the gage detects a deviation from nominal strip thickness, it transmits an impulse to the two P&W Control Units which operate to bring the strip back to size automatically. One control corrects the mill screw-down, the other adjusts the tension.

THE RECORDER and INDICATING METERS To provide the permanent production record essential to maintaining rigid, long-term control of strip quality, a P&W Direct-Reading Recorder is incorporated in the installation. This instrument continuously registers *actual strip size* in .0001" increments. As a further check, two indicators (one for each gage) are also provided. These give the mill operator a continuous reading of *strip deviation from nominal* in .00005" increments.

THE TOTALIZER and CARD PRINTER Incorporated in the Control Desk, a P&W Totalizer gives, at a glance, the totals of oversize, undersize, on-size and complete footage in each coil of strip. Providing a permanent record of these totals, a separate Card Printer is located adjacent to the desk. Following the last pass, the operator inserts a card into the Printer, and the information supplied by the Totalizer – plus the date, time, and operator's number – is automatically printed on the card.



. . . the Ultimate in Automation Gaging

FROM ONE SOURCE, ONE RESPONSIBILITY

. . . COMPLETE AUTOMATIC CONTROL SYSTEMS — ENGINEERED TO MEET INDIVIDUAL REQUIREMENTS EXACTLY — FOR MODERN ROLLING MILLS

THE WALLINGFORD STEEL COMPANY of Wallingford, Connecticut, has built an enviable reputation, specializing in stainless steel strip (and tubing made from its own strip) that meets the rigid specifications of exacting customers. Because their requirements permit no compromise with the highest standards of uniform product quality, Wallingford has always invested in the finest, most advanced equipment available. So Pratt & Whitney Automation Gaging was a logical choice. Applied to Wallingford's Sendzimir Mill, this system provides continuous, non-contacting gaging *plus completely automatic* correction of the mill to maintain strip thickness within required tolerances *at all times!*

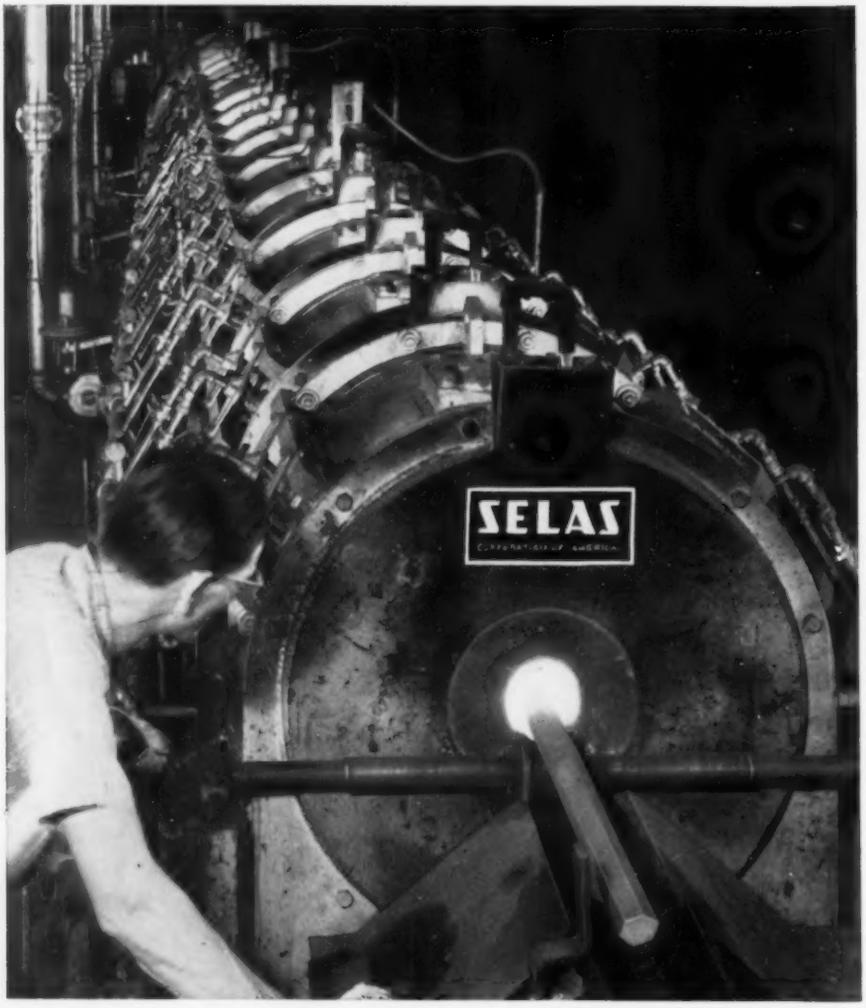
Phone the P & W Branch Office near you and request a Pratt & Whitney Gage Engineer to call and analyze your requirements . . . or write direct to Pratt & Whitney Company, Incorporated, 28 Charter Oak Boulevard, West Hartford 1, Conn.

PRATT & WHITNEY

FIRST CHOICE FOR ACCURACY

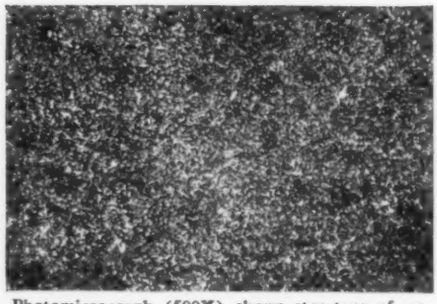
MACHINE TOOLS • GAGES • CUTTING TOOLS

Physical properties improved, uniformity achieved



with

Selas short-cycle hardening and tempering



Photomicrograph (500X) shows structure of an AISI 4140 steel bar, hardened and tempered with Selas short-cycle heating. Yield Strength = 140,000 psi; Tensile Strength = 152,000 psi; Hardness = 32 Rc. Compare this with conventional heating methods, which for 152,000 psi T. S. produce only 115,000 psi Y. S., and to achieve the required 140,000 psi Y. S., it is necessary to go to 180,000 psi T. S., with hardnesses that introduce machining problems.

FOR a given tensile strength or hardness, Selas short-cycle hardening and tempering develops higher yield strength . . . with no sacrifice in ductility . . . in carbon and low alloy steel bars. For with Selas short-cycle heating, a higher tempering temperature can be employed (with no soaking), which enables more complete relief of residual hardening stresses.

Surface decarburization is reported to be negligible, scaling is minimized . . . even though no specially-prepared atmosphere is employed.

Selas fast heating for hardening, quenching and short-cycle tempering of bars is performed continuously, automatically. Consistent metallurgical uniformity is obtained throughout each bar and from bar to bar.

Selas barrel-furnace lines are also widely used throughout the steel industry for hardening, tempering and annealing seamless tubes; heating seamless tubes for sizing; normalizing welded pipe . . . all continuous operations.

The compact, fast heating, gas-fired furnaces save valuable floor space and are adaptable to variations in production-line speeds.

Send for informative articles on Selas tube and bar heating installations. Address Dept. 43.

SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

CINDER POT CARS

USS-DESIGNED

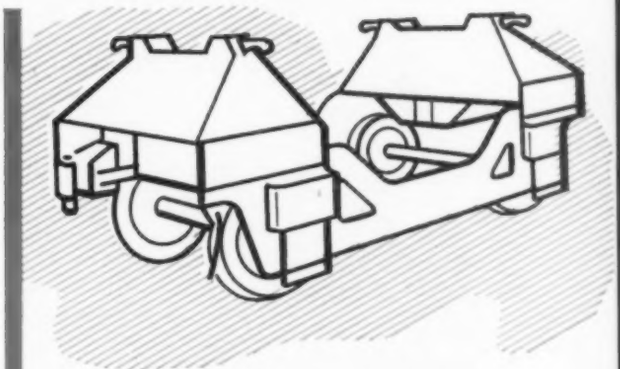
to your specifications

No matter what kind of industrial car you need in your steel plant, United States Steel can probably supply it. Our engineers specialize in designing and building most types and sizes of industrial cars.

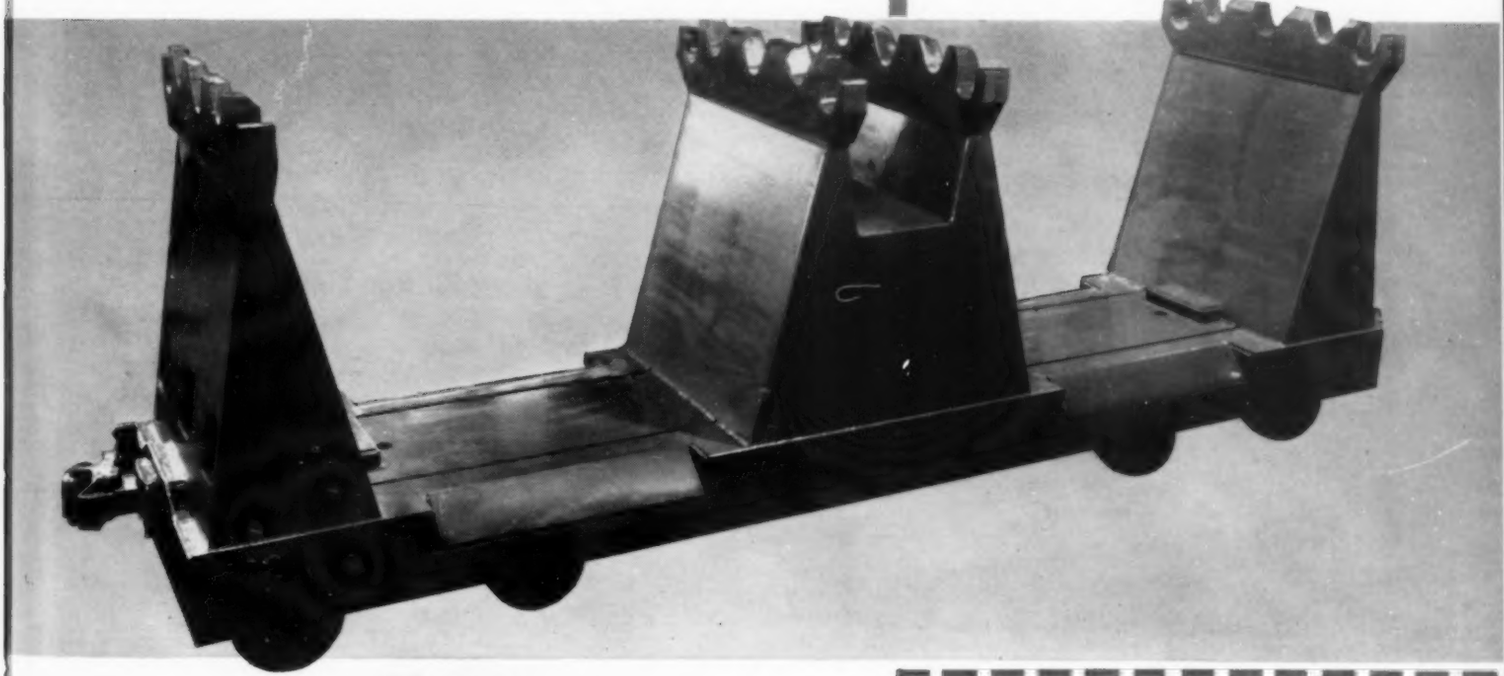
Cinder pot cars, for example, can be built in accordance with your drawings, or they can be completely engineered by us to meet your operating conditions. United States Steel manufactures not only the cars, but the cinder pots and trunnion rings as well.

USS-Designed Cinder Pot Cars can be built to carry either one or two pots. They can be dumped from either side. All cars are of welded steel construction.

Send for a free copy of our 32-page illustrated booklet—"USS Custom Designed Cars." And, at any time, call in our engineers for consultation.



Cinder pot car has a capacity of 400,000 pounds; carries two 600 cubic-foot pots. Trucks are interchangeable with those on ingot mold cars built for same customer.



USS INDUSTRIAL CARS

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

United States Steel Corporation
525 William Penn Place, Room 5598
Pittsburgh 30, Pennsylvania

Please send me a free copy of your 32-page booklet, "USS Custom Designed Cars."

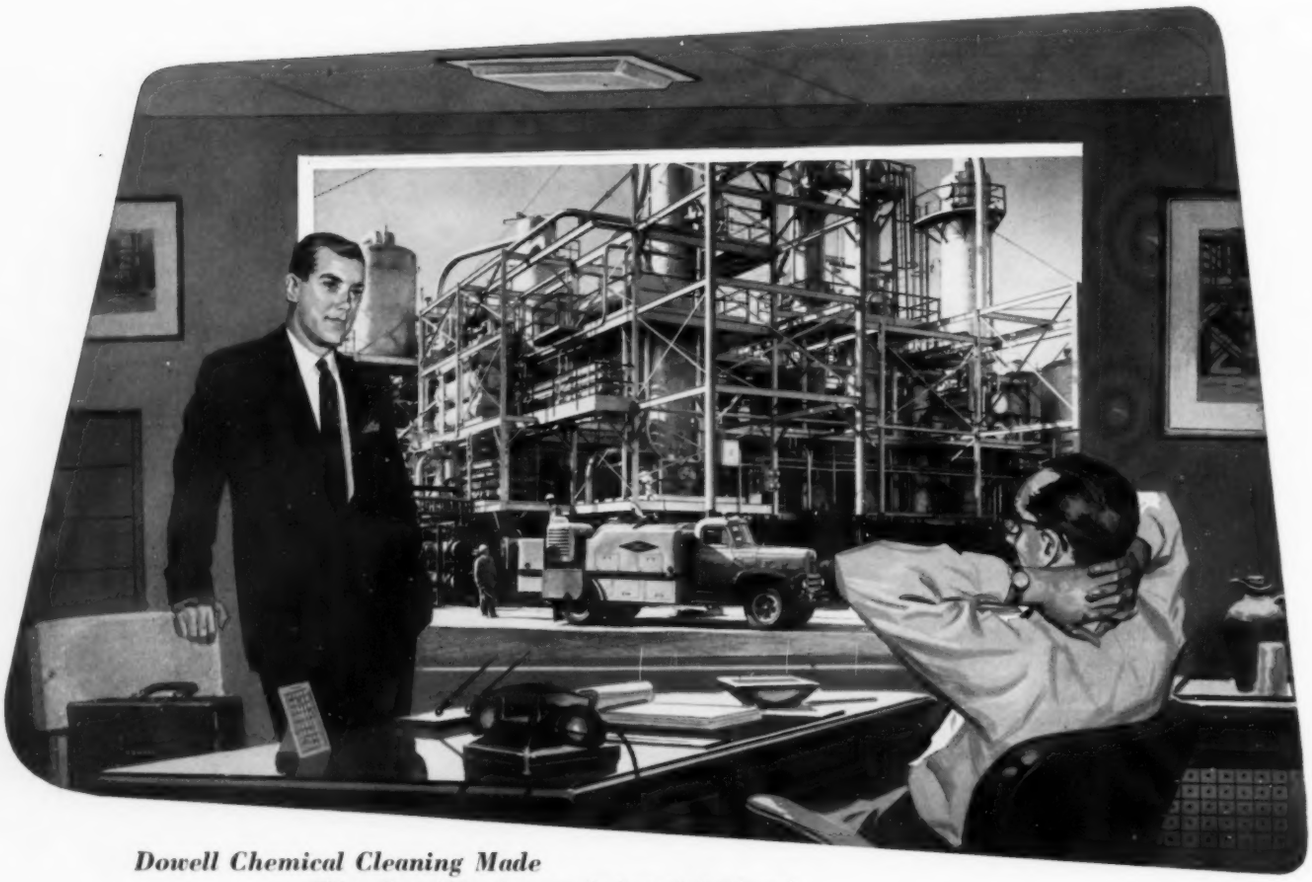
Name .....

Company .....

Address .....

City ..... State .....

how would you like to add $250,000.00 to your profit?



Dowell Chemical Cleaning Made This Possible for an Industrial Plant!

In 1954 an East Coast plant employed Dowell Chemical Cleaning Service on a limited basis. The results were encouraging.

In 1955 the same company expanded its use of chemical cleaning. The results were startling. More throughput, less down time, and greater overall plant efficiency effected nearly a *$250,000.00 saving!*

In 1956 the program was continued. The result: still more savings. Eventually, chemical cleaning on a continuing year-around basis is expected to effect savings of from $300,000.00 to $500,000.00 annually.

This case history is about an oil refinery. However, Dowell has eye-opening performance data to show you in almost any industry.

Dowell engineers are experts in the use of solvents to remove scales and sludges—those deposits that cut the capacity of process and steam generating systems. Dowell does the job for you and furnishes all necessary chemicals, trained personnel, pumping and control equipment.

For additional information, call the Dowell office near you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

clean it chemically **DOWELL**

A SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

February 1

▲ The AISC reports that shipments of fabricated structural steel for December, 1956, amounts to 297,785 tons compared with 276,045 tons in November, 1956, and 248,017 tons in December, 1955. Bookings totaled 404,429 tons in December compared with 338,892 tons in November, 1956, and 367,827 tons in December, 1955. Backlog on December 31 was 3,373,375 tons. Annual shipments for 1956 totaled 3,250,488 tons compared with 2,982,257 tons in 1955.

February 4

▲ The BDSA's report to Congress on a survey of scrap supply and demand predicted that the present rate of steel and iron scrap consumption, if continued, will tend to deplete U. S. reserves in the distant future.

▲ Competitive price cutting of extruded aluminum products has resulted in slashes of as much as 20 per cent in the prices of products of extrusions.

▲ Auto production in January, 1956, totaled 642,094 cars, about 5 per cent above January, 1955. Sales of new cars in January, 1956, are indicated at about the 480,000 January, 1955, level.

▲ Installment debt in December, 1956, increased $528,000,000, compared with $751,000,000 rise in December, 1955, with the total outstanding, December 31, 1956, $31,500,000,000, an increase of $2,500,000,000 during 1956.

▲ The AISI reports that the operating rate of the steel industry for the week of February 4 is scheduled at 96.6 per cent of capacity. This is equivalent to 2,472,000 tons compared with 2,498,000 tons one week ago and 2,439,000 tons one year ago. Index of production for the week is 153.9.

February 5

▲ Secretary Humphrey asserted that the next general tax cut would result only from reduced government spending rather than increased Federal revenues, stating that the high present tax rate in the long run will hamper our economic growth.

▲ 1956 volume of commercial exports reached $17,300,000,000, $3,000,000,000 higher than 1955. Shipments abroad in December, 1956, totaled $1,900,000,000, $600,000,000 above December, 1955.

▲ Prices of spot copper in London declined to 31 1/8¢ down 3/8¢ from last week's close.

February 6

▲ Steel scrap price declined $3.00 a ton at Youngstown with one mill buying No. 1 heavy melting scrap for $54.00 a ton.

▲ The ICC granted a 5 per cent advance in freight rates to southeastern railroads.

February 7

▲ Custom smelters cut price for copper to 33¢ a lb, a 1¢ reduction. In London, spot copper dropped to 30 3/4¢ a lb.

▲ Federal Maritime Administrator Morse reported to the House Merchant Marine Committee that U. S. shipbuilders estimate they will receive only about 60 per cent of their steel plate requirements over the next 17 months, estimating requirements up to mid-1958 of about 700,000 and counting on delivery of only 415,000 tons.

▲ Ford Motor Co. reported net profits for 1956 of $4.38 a share compared with $8.19 in 1955, sales for 1956 totaled $4,600,000,000, down 16.9 per cent from 1955; the company spent $530,000,000 for expansion and modernization in 1956.

▲ The Commerce Dept. reported that personal income for December, 1956, was at $333,500,000,000 annual rate, unchanged from November, 1956; personal income for the year 1956 amounted to $325,200,000,000 compared with $306,100,000,000 in 1955.

▲ Northeastern Steel Corp., filed a petition with the U. S. District Court in New Haven for reorganization under Chapter 10 of the National Bankruptcy Act. The corporation notified the court that they would default on interest payments due on 6 per cent debentures. The corporation reported a net loss of $1,154,422 for the first 9 months in 1956.

February 8

▲ Federal Judge Henry Brooks at Owensboro ruled that Jessop Steel Co. can take over Green River Steel Co., and approved a plan clearing the way for an exchange of Green River stock for Jessop shares, payment of interest on Green River bonds and a $1,500,000 loan to the plant at Owensboro for expansion. The court order will become effective March 4, making Green River a wholly owned subsidiary of Jessop.

▲ The Committee of Stainless Steel Producers, AISI announced that stainless steel production in 1956 set a new record at 1,210,569 tons compared with 1,161,177 net tons in 1955.

▲ Price increases of 25¢ a ton for soft coal, effective April 1, are being proposed by producers in price negotiations with leading electric utilities.

▲ The American Can Company announced that can production in the U. S. for the first 11 months of 1956 amounted to 39,400,000,000 containers, approximately 2,700,000,000 over the same period in 1955.

February 11

▲ U. S. Steel Corp. raised base prices of steel pipe an average of about 3 1/2 per cent, and boosted "extra" charges on a number of other products about 4 per cent.

▲ The AISI reports that the operating rate of the steel industry for the week of February 11 is scheduled

at 96.5 per cent of capacity. This is equivalent to 2,469,000 tons compared with 2,485,000 tons one week ago and 2,433,000 tons one year ago. Index of production for the week is 153.7.

▲ U. S. Dept. of Interior, Bureau of Mines reported that production of primary aluminum in the U. S. for November, 1956, totaled 145,081 short tons, compared with 149,125 tons in October, 1956, and 133,689 tons in November, 1955.

February 12

▲ A market survey conducted by Lukens Steel Co. predicted shipments of finished steel of about 85,000,000 to 87,000,000 tons, compared with an estimated 83,000,000 in 1956, which level of finished steel would require 118,000,000 to 120,000,000 tons of steel ingot production.

February 13

▲ The AISI reported January, 1957, steel output at 11,001,000 net tons, second highest in history, compared with 10,837,545 net tons in December, 1956, and 10,828,231 net tons in January, 1956.

▲ Six eastern railroads pushed their plea to the ICC for a 40 per cent increase in first-class passenger fares; other railroads have refused to join the petition stating such a drastic increase will price first-class rail travel out of the market.

February 14

▲ The VA reported that home building starts under the G.I. program dropped to 11,984 units in January, 1957, compared with 19,029 starts in December, 1956, and 29,284 starts in January, 1956.

▲ Auto production this week will rise to 150,370 cars, 17 per cent greater than a year ago, and puts assemblies for 1957 ahead of the 1956 period.

▲ Business loans by leading New York City banks rose $90,000,000 in the week ended February 13, reversing a downward trend in effect since December 19. So far in 1957 business loans of these banks have decreased $382,000,000, compared with a contraction of $184,000,000 during the same 1956 period.

▲ AISI estimated payroll for the iron and steel industry at 1956 at $3,795,975,000, nearly $200,000,000 higher than in 1955; average hourly payroll cost for wage earners reached a new high at $2.70, which does not include the average cost of about 25¢ an hour for fringes; industry's employment was estimated at 653,400 in 1956 down 4,000 from 1955; with average hours per week worked at 38.6.

February 18

▲ Barium Steel Corp. declared a cash dividend of 15¢ and a stock dividend of 2 per cent, payable April 16, to stock holders of record March 27. Directors also voted redemption of outstanding $3,800,000 5½ per cent convertible debentures due September 15, 1968.

▲ Phelps Dodge Corp. lowered copper prices to 32¢ per lb, down 2¢. In London spot copper closed Friday Feb. 15 at 30¾¢, up ¼¢ on the week.

▲ The AISI reports that the operating rate of the steel industry for the week of February 18 is scheduled at 96.7 per cent of capacity. This is equivalent to 2,475,000 tons compared with 2,501,000 tons one week ago and 2,433,000 tons one year ago. Index of production for the week is 154.1.

February 19

▲ The Bureau of Mines reports that the consumption of scrap during December, 1956, totaled 6,268,000 gross tons and pig iron 6,402,000 gross tons compared with 6,305,947 tons of scrap and 6,237,538 tons of pig iron in November.

▲ Shipments of iron and steel castings during November, 1956, amounted to 1,422,396 short tons compared with 1,531,892 short tons in October, 1956, and 1,557,294 short tons in November, 1955.

February 20

▲ Texas authorities raised the March limit for crude oil production to 3,733,054 barrels daily, an increase of 210,901 barrels daily over the current allowable and 380,000 barrels higher than the ceiling available when the Suez canal was closed last November.

▲ The Aluminum Assn. reports primary aluminum production in the United States during January, 1957, was 147,030 short tons compared with 148,391 short tons in December, 1956, and 140,394 tons in January, 1956. Total for 1956 amounted to 1,679,247 short tons.

▲ ARCI reports that deliveries of new domestic freight cars in January, 1957, totaled 7,822 compared with 7,260 cars in December, 1956, and 4,199 cars in January, 1956. Orders totalled 5,328 in January, 1957, compared with 4,992 in December, 1956, and 1,818 in January, 1956. Backlog of cars on order as of February 1, 1957, stood at 114,656 cars.

February 21

▲ GE financial report for the year 1956 showed sales totaling $4,090,015,685, net profit of $213,756,849 and earnings per share of $2.46 compared with sales of $3,463,734,419, net profit of $208,908,054 and earnings per share of $2.41 for fiscal year 1955.

▲ Prices of copper were reduced another 1¢ to 31¢ a lb by custom smelters, the lowest price prevalent since the 30¢ price in effect January 27, 1955. In London spot copper moved up ⅛¢ to 30⅜¢ a lb.

▲ The Babcock & Wilcox Co., board of directors, approved a plan of financing providing the issue and sale of 535,148 shares of capital stock offered for subscription at the ratio of 1 new share for each 10 shares held.

▲ The Industrial Heating Equipment Assn. reported that orders for industrial furnaces during January, 1957, amounted to $7,380,000 compared with $10,244,000 for January, 1956, shipments for 1956 totaled $123,344,000 compared with $77,758,000 for 1955 for the membership of the Association.

February 25

▲ R. O. Gray, president of Armco announced the corporation will spend only $50,000,000 to expand its Ashland, Ky., and Houston plants, modifications of former plans for expanding to the extent of $136,000,000 at Ashland and $118,000,000 at Houston because of government denial for fast write-offs.

▲ The AISI reports that the operating rate of the steel industry for the week of February 25 is scheduled at 96.0 per cent of capacity. This is equivalent to 2,456,000 tons compared with 2,504,000 tons one week ago and 2,459,000 tons one year ago. Index of production for the week is 152.9.

Steel Companies Quarterly Financial Reports—Ending Dec. 31, 1956

	Period	1956 Net sales	1956 Net profit	1956 Earnings per share	1955 Net sales	1955 Net profit	1955 Earnings per share
Acme Steel Co.	Fourth quarter	$ 45,749,000	$ 1,834,000	$ 0.77	$ 30,507,000	$ 1,364,000	$ 0.69
	year	134,162,248	6,723,529	3.20	109,861,392	6,172,119	3.11
Allegheny Ludlum	Fourth quarter	83,360,920	5,614,067	1.48	73,415,057	4,554,494	1.26
	year	285,959,267	15,261,090	4.04	255,240,619	14,985,660	4.12
Allan Wood Steel Co.	Year	69,330,000	3,096,000	4.04	58,376,000	2,552,000	3.32
Algoma Steel Corp., Ltd.	Year	....	15,714,393	9.52	....	10,441,834	6.33
Armco Steel	Year	761,800,000	65,250,000	6.00	692,683,234	64,350,609	6.05
Barium Steel Corp.	Year	119,300,000	6,560,000	1.85	75,084,700	655,318	0.20
Bethlehem Steel Corp.	Fourth quarter	667,184,493	61,721,468	5.95	572,794,243	57,502,400	5.82
	year	2,326,705,414	161,411,625	15.33	2,096,616,646	180,191,708	18.09
Copperweld Steel	Fourth quarter	26,520,478	945,168	1.13	22,659,956	697,972	0.84
	year	100,541,926	3,440,872	4.08	78,490,150	2,365,459	2.81
Continental Steel Corp.	Fourth quarter	46,703,332	2,793,574	5.57	44,881,747	3,022,143	6.02
	year						
Crucible Steel Co.	Year	263,922,898	12,767,625	7.02	237,715,380	13,208,602	7.26
Detroit Steel Corp.	Year	123,359,756	8,747,092	2.78	101,803,010	6,317,860	2.07
Granite City Steel	Year	137,131,000	15,109,000	7.04	116,293,657	12,610,820	5.87
Inland Steel Co.	Year	731,585,400	52,998,726	9.43	663,317,374	52,466,098	9.52
Jessop Steel Co.	Year	....	1,500,000	3.00	....	700,254	1.42
Jones & Laughlin Steel	Fourth quarter	204,695,000	12,853,000	1.90	182,857,000	15,269,000	2.26
	year	742,642,000	45,122,000	6.63	696,538,000	50,104,000	7.39
Keystone Steel & Wire	Fourth quarter	26,314,493	1,821,740	0.97	26,839,447	2,191,550	1.17
	last six months	50,499,723	3,549,455	1.89	51,260,422	4,350,293	2.32
Lone Star Steel Co.	Year	88,650,000	10,151,000	3.84	74,489,000	4,759,000	1.80
McLouth Steel Corp.	Year	....	8,806,000	..	....	8,148,000	..
National Steel Corp.	Fourth quarter	183,265,707	17,026,363	2.29	159,466,929	13,787,776	1.86
	year	664,251,090	52,502,422	7.09	622,018,919	48,289,453	6.54
Pittsburgh Steel Co.	Fourth quarter	178,275,626	6,225,000	3.24	176,732,232	7,515,470	4.09
	year						
Republic Steel Corp.	Year	1,251,628,903	90,406,665	5.83	1,195,094,731	86,271,491	5.59
Sharon Steel Co.	Fourth quarter	180,044,408	6,905,530	6.28	173,095,949	7,987,622	7.26
	year						
United States Steel Co.	Fourth quarter	1,194,587,925	104,528,839	1.83	1,093,747,901	102,690,682	1.80
	year	4,228,869,270	347,865,150	6.01	4,097,680,287	370,099,353	6.44
Wheeling Steel Co.	Fourth quarter	256,320,000	17,672,000	8.20	246,695,000	17,296,000	8.12
	year						
Youngstown Sheet and Tube Co.	Year	684,041,021	43,174,587	12.62	626,232,840	41,701,140	12.34

▲ Resistance Welders Manufacturers Assn. reports shipments by members in January exceeded $3,000,000; backlog on February 1, 1957, was over $12,000,000.

February 26

▲ Reynolds Metals Co. announced net sales for 1956 amounted to $405,206,005, net profit $41,239,902 or $3.93 per share compared with sales of $384,887,793, net profit $34,306,521 or $3.41 a share in 1955.

▲ Financial report for 1956 by Allis-Chalmers Manufacturing Co. showed sales for the year of $547,439,265, profit of $20,355,045 or $2.42 per common share, compared with sales of $535,069,085, profit of $24,805,326 or $3.03 per common share in 1955.

▲ The annual report of Mesta Machine Co. shows net income of $4,364,727 or $4.36 per share in 1956 compared with net income of $3,653,945 or $3.65 per share in 1955.

▲ Oil shipments to Europe are now about 75 per cent to 90 per cent of its requirements, reported Assistant Interior Secretary Wormser to the American Institute of Mining at its annual meeting.

▲ General Motors Corp. reported sales for 1956 totaling $10,796,442,575, net income $847,396,102 or $3.02 per share compared with sales of $12,443,277,420, net income of $1,189,477,082 or $4.30 a share in 1955. Vehicles sold in 1956 totaled 4,090,863 compared with 5,030,994 in 1955.

February 28

▲ Lone Star Steel Co.'s directors took action to cancel 1,000,000 shares of authorized but unissued stock, and to declare a 10 per cent stock dividend.

▲ The Board of Directors of the Colorado Fuel and Iron Corp. declared the regular quarterly dividend of 50¢ per share on outstanding common stock on record March 11, 1957.

▲ Westinghouse Electric Corp. reports sales of $1,525,375,771 and income of $3,492,061 for 1956 compared with sales of $1,440,976,985 and income of $42,802,747 in 1955.

▲ Phoenix-Rheinrohr A-G., Duesseldorf, Germany, reported for fiscal 1955–56 (October 1 to September 30) sales totaling $333,800,000 net profit of $4,435,000 or $2.14 per share compared with sales of $295,000,000, net profit of $3,450,000 or $1.67 a share in fiscal 1954–55. Production of crude steel in 1955–56 totaled 2,418,998 metric tons compared with 2,216,256 metric tons in 1954–55.

▲ Kaiser Aluminum & Chemical Corp. announced net sales for 1956 were $343,626,585, earnings $42,349,131 equivalent to $2.71 per common share compared with sales of $301,031,135 earnings of $36,021,114 equivalent to $2.43 per share in 1955.

CHILE COLOMBIA PERU ARGENTINA PORTUGAL SPAIN SWEDEN U.S.A.
CANADA JAPAN BELGIUM MEXICO AUSTRIA INDIA ISRAEL BRAZIL ITALY GERMANY URUGUAY ENGLAND DENMARK FINLAND FRANCE SO. AFRICA

FREE ENTERPRISE IN 24 NATIONS UNITED...

on Choice of Yoder Mills for Pipe and Tube Manufacture

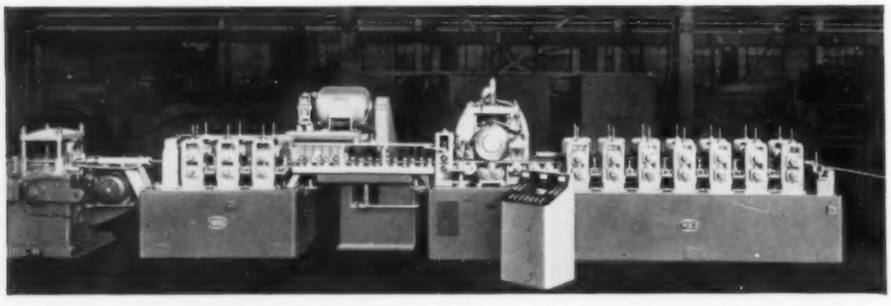
It all started less than two decades ago with the introduction by Yoder—and the rapid adoption by American industry—of a revolutionary new type of mills for cold forming and electric-resistance welding of pipe and tubing. England, France, Italy, Mexico, Argentina, and Brazil soon followed the U.S.A. in adopting Yoder mills. Most other countries which boast any kind of modern metal working industry also invested in one or more Yoder mills, including distant Japan, India, and South Africa. Production, depending on requirements, varies from 25,000 up to 75,000 feet per 8-hour shift.

By this time, England, Italy and Argentina each have a total of ten Yoder mills in operation; Brazil, eight; Mexico, six; France, five; other countries somewhat in proportion to their population. In many nations, Yoder mills now supply from 50% to 90% of all the welded tubes used.

The geographical distance which separates Yoder from many of these countries has proved much less a handicap than might be supposed. Reasons: the simplicity of design, ease of operation and dependability of Yoder mills. Secondly, generous assistance rendered by Yoder in training operators everywhere. In fact, several outstanding production records have been scored by operators in foreign countries, most recently in Italy.

Through technological advances, Yoder leadership in tube mill design has been jealously preserved and strengthened from year to year. Ask for literature giving details of the latest improvements. Correspondence invited.

THE YODER COMPANY
5495 Walworth Ave., Cleveland 2, Ohio, U.S.A.

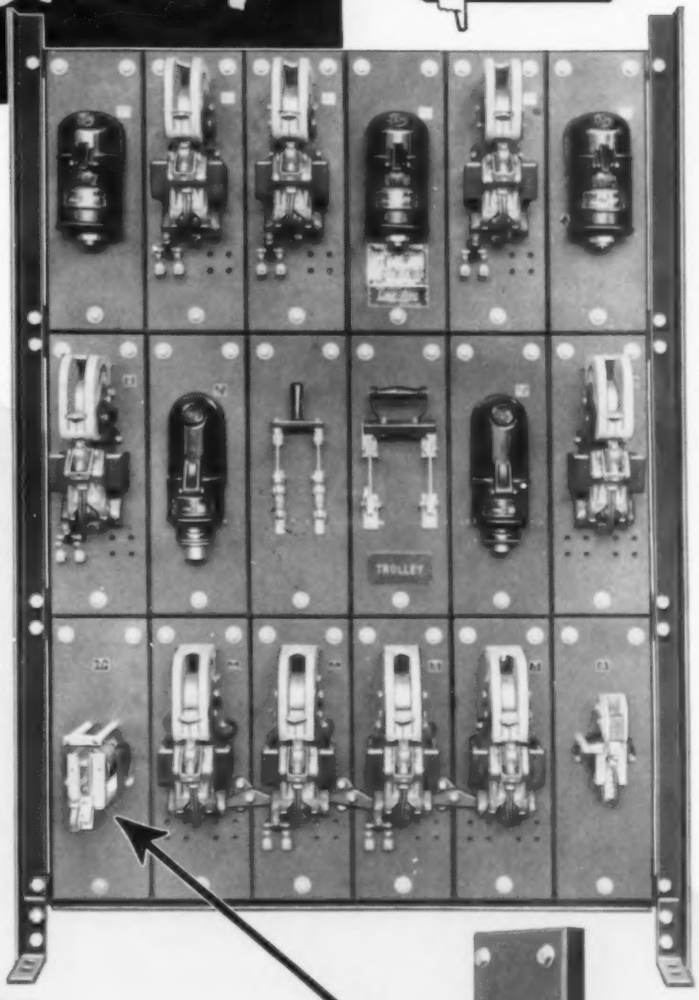


ENGINEERING YODER MANUFACTURING

PIPE AND TUBE MILLS—Electric Weld
ROTARY SLITTING LINES
COLD ROLL FORMING MACHINES

when stopping DC Motors

EC&M's Rectifier Plugging Control System gives FULL PROTECTION!

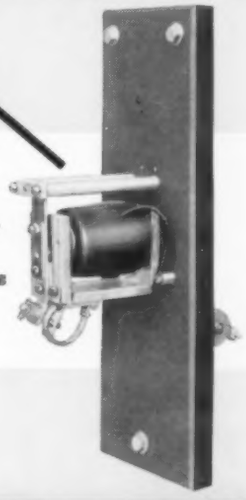


• This is the simplest of all plugging control systems for D.C. mill and crane drives. Only a small rectifier and single-coil mill-duty relay are required. They are connected across the motor armature for operation by counter-emf. The relay allows the plugging contactor to close immediately when starting from rest. When reverse-power plugging is applied to stop the motor, the rectifier permits the relay to pick up and hold open the plugging contactor. As the motor reaches stand-still, the relay drops out to close the plugging contactor and to allow acceleration in the opposite direction.

TWO-STEP PLUGGING CONTROLLERS are available for use on heavy inertia loads such as ore bridge trolleys and ladle crane bridge motions. Ask an EC&M Engineer to explain the improved operation of D.C. motors by Rectifier Plugging.

HERE'S WHY EC&M GIVES MOTOR DRIVES BETTER PROTECTION

- ✓ **POSITIVE RESPONSE** • Relay operates directly from counter-emf of motor.
- ✓ **RELIABLE OPERATION** • Unaffected by line voltage variation. Unaltered if taps on accelerating or plugging resistors are changed.
- ✓ **FULL PROTECTION** • Relay picks up at any speed above 10% of F. L. motor speed. Drop-out occurs as motor reaches standstill.
- ✓ **SIMPLICITY** • Single-coil relay and small rectifier. No electrical interlocks.
- ✓ **LESS MAINTENANCE** • Relay does not require adjustment-maintenance.

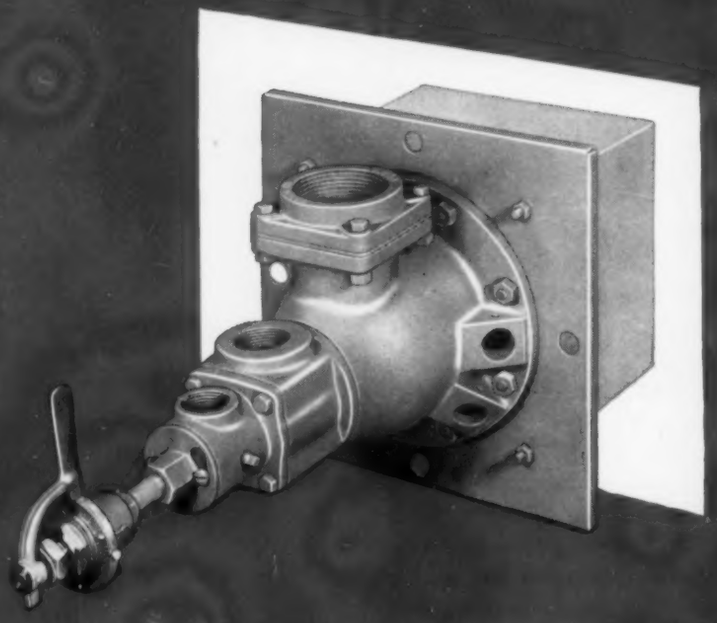


View of Type FKP Relay used on EC&M D-C Magnetic Controllers

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

7406

NORTH AMERICAN



series 223

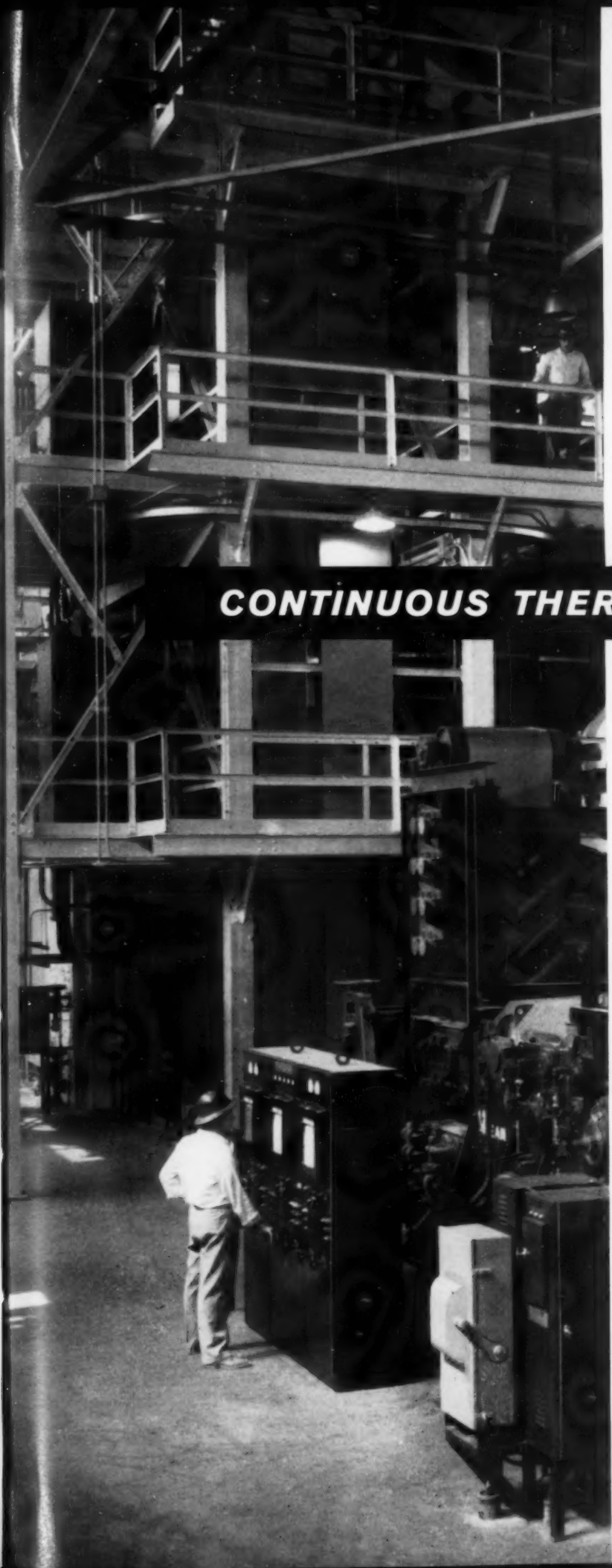
XSA Dual-Fuel Burners

A Sealed-in Excess Air Burner
For Rich or Lean Operation
On Gas or Light Oil
With Flame Safety

For detailed engineering information, consult your nearby North American combustion specialist or write for bulletin 223

NORTH AMERICAN for COMBUSTION
Since 1917

The NORTH AMERICAN Manufacturing Co.
Combustion Engineers
Cleveland 5, Ohio



CONTINUOUS THERMAL PROCESSING...

more steel... improved quality!

A significant first in the steel industry has resulted from the recent installation of three new and identical annealing lines, each designed to deliver 20 tons of improved-quality silicon steel per hour.

This continuous annealing operation in a limited area created an unusual problem in control accuracy and reliability. Westinghouse MAGAMP* magnetic amplifier regulators form the heart of the control system . . . make this the first all-magnetic amplifier continuous annealing line. Westinghouse furnished complete electric equipment and furnaces for all three lines.

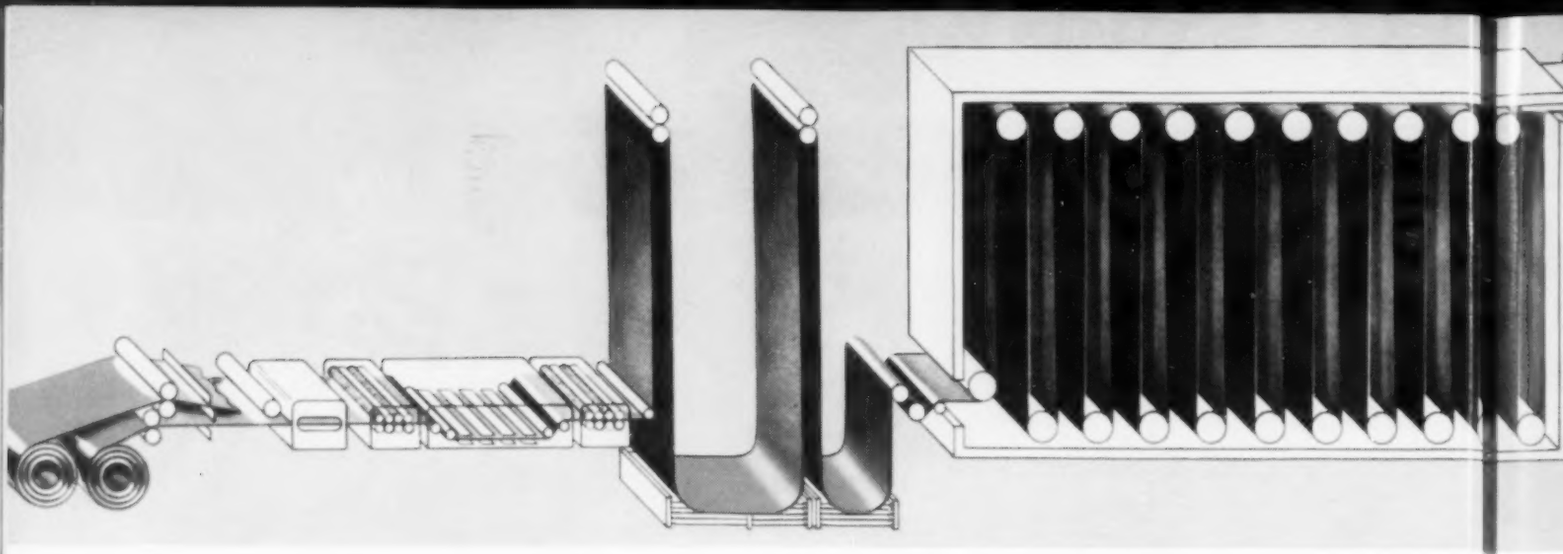
And . . .

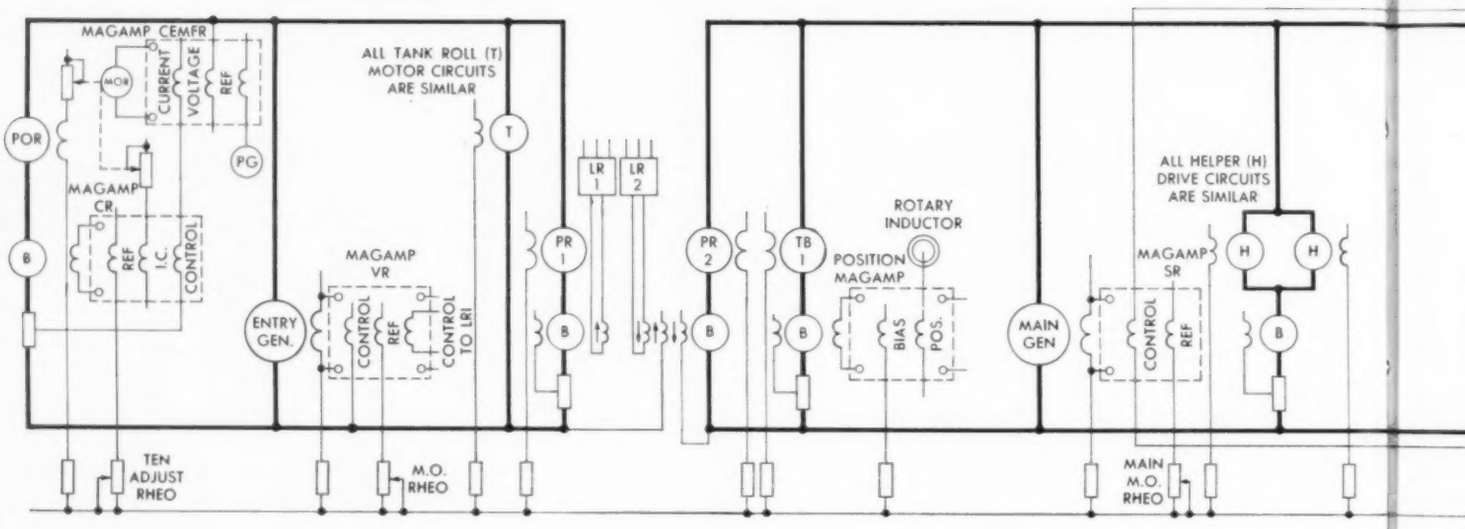
Here's another big development in the steel industry ——→

*Trade-Mark

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***





Tin-plate annealing equipment designed for . . .

Process speeds beyond 2000 fpm, output 60 tons per hour!

Tin-plate annealing lines now being built will be capable of boosting output as much as 100% over existing continuous lines.

Continuous annealing lines are from 300 to 400 feet in floor length. Since the strip travels through many vertical passes, several thousand feet of tin plate are accommodated in the line between the pay-off and winding reels.

High-speed annealing operations like this demand the ultimate in coordination and reliability. Westinghouse motors, controls, furnaces and related equipment will help you handle speed and output up to and beyond 2000 fpm, 60 tons per hour—while maintaining precise quality standards. Moreover, Westinghouse accepts full unit responsibility for the electric and furnace equipment installed in your line.

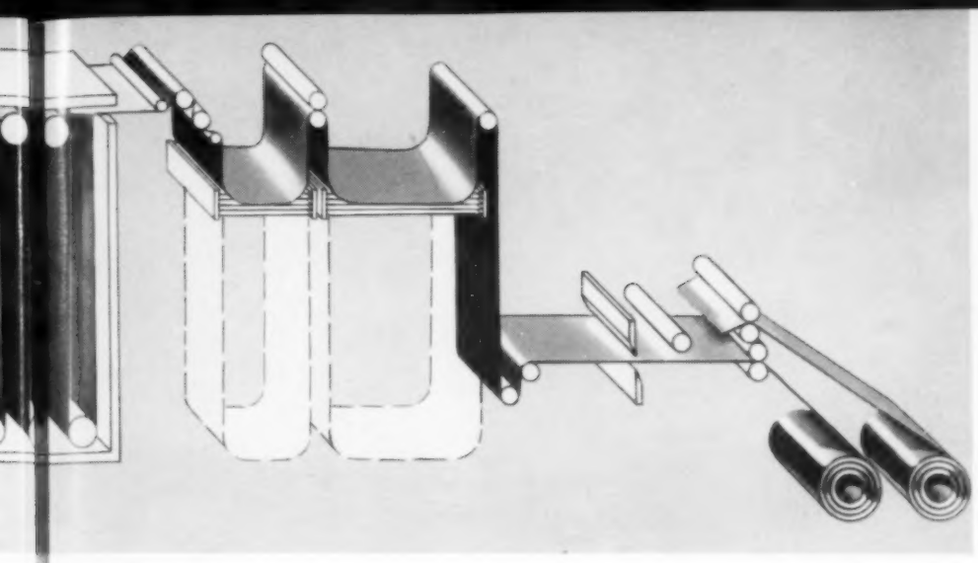
How Line Control Operates

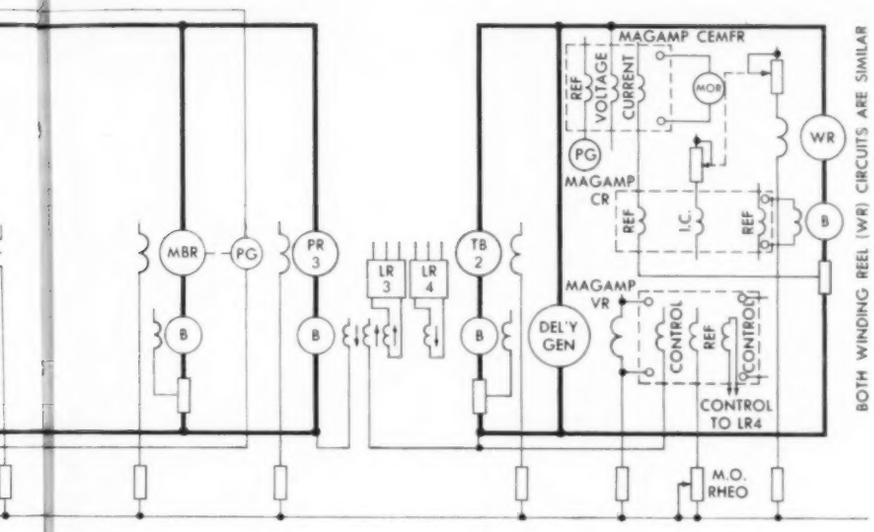
Westinghouse has many years of successful experience applying MAGAMP regulators to drive systems. Above diagrams show how Westinghouse MAGAMP regulators are applied in modern, continuous annealing lines.

MAGAMP speed regulator (SR) maintains constant speed through the critical annealing zone. Speed reference, set by main motor-operated rheostat (MOR), is

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***





balanced by the control winding fed from the pilot generator (PG) driven by the master bridle roll (MBR).

MAGAMP voltage regulators (VR) control the voltage of the entry and delivery generators assuring fast, even acceleration and deceleration and a minimum of loop disturbance during steady operation. Loop regulators set as verniers in controlling generator voltages.

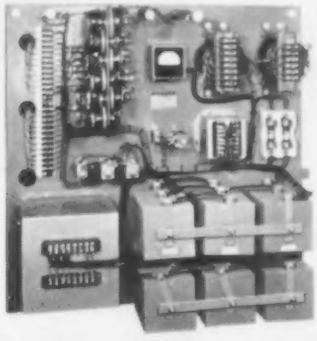
MAGAMP current regulator (CR) for booster, and MAGAMP counter-EMF regulator (CEMFR) for motor, work together so regulated tension is maintained by the pay-off reels (POR) and winding reels (WR). Inertia compensation (IC), proportional to accelerating loads, and stall tension signals are introduced through the (CR) circuits.

Photo-thyratron loop regulators (LR) provide modulated control of storage loops for smooth operation.

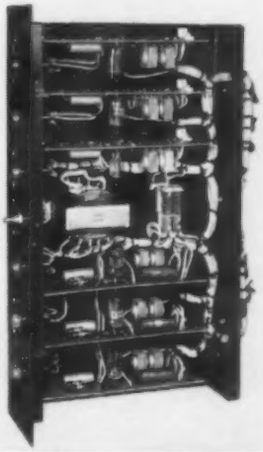
Machine characteristics are selected for best drive performance. Pinch roll no. 1 (PR-1), master bridle roll (MBR), and tension bridle no. 2 (TB-2), the pacesetters of their respective line sections, are shunt-wound for flat, speed-load characteristic. Helper drives (H) have high drooping characteristics which result in their developing only the power required to overcome their friction losses and inertia loads. Reel motors have high overload capacities suitable for accelerating the large coils which are now used in most mills.

MP-3044

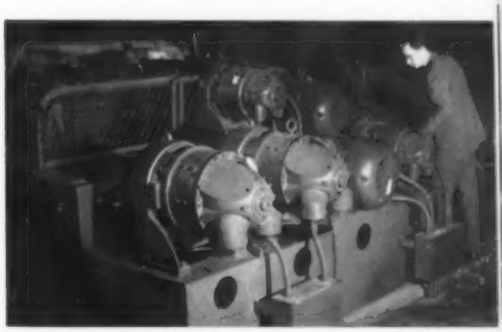
Centralized line control reduces space requirements and provides ready accessibility for inspection.



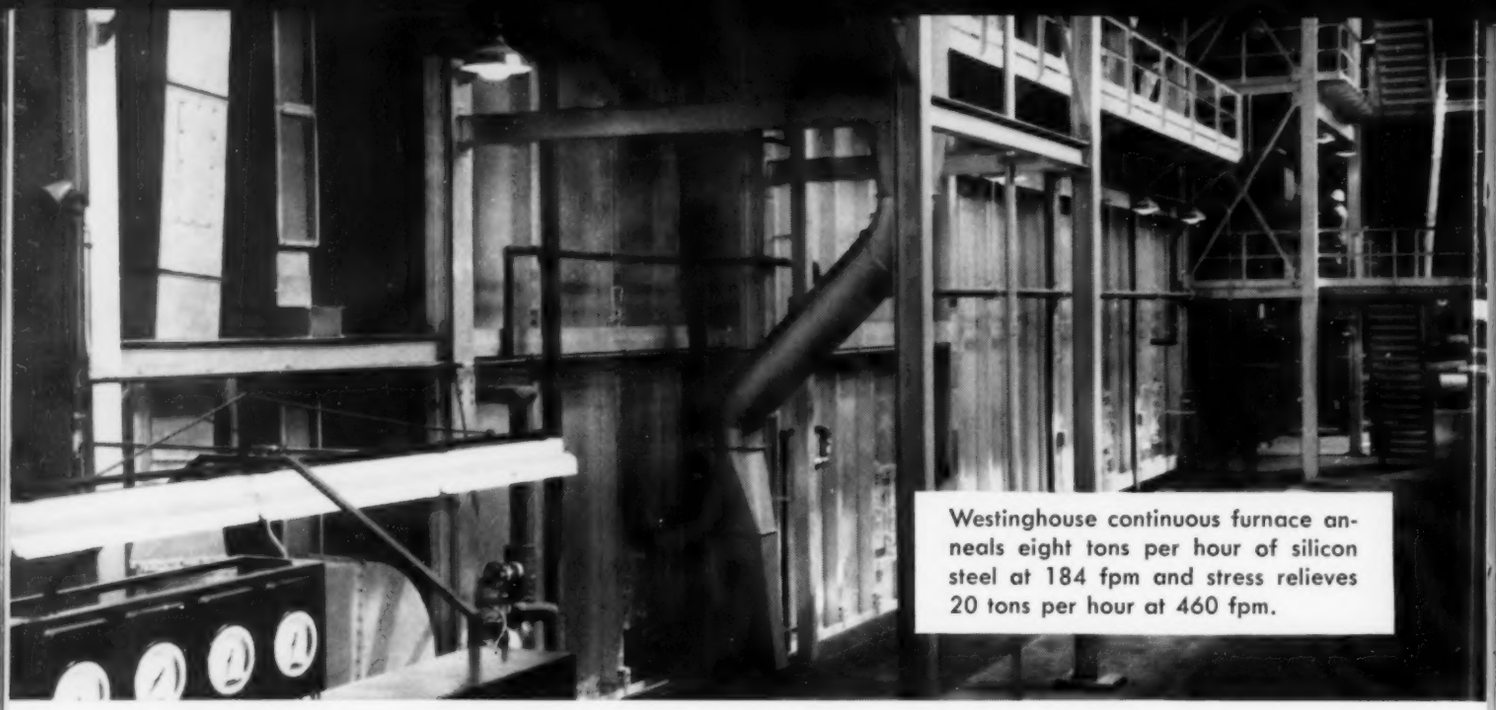
Magamps bring outstanding precision, dependability to line control . . . no moving parts, brushes, commutators, bearings.



New Westinghouse fault finder monitors control circuits simultaneously, indicates faults instantly and makes trouble-shooting easy.



Westinghouse d-c motors perform efficiently under tough conditions. High starting torque ideal for high inertia loads.



Westinghouse continuous furnace anneals eight tons per hour of silicon steel at 184 fpm and stress relieves 20 tons per hour at 460 fpm.

Three ways Westinghouse furnaces match increased annealing speed

Westinghouse gas and electric furnaces meet the demands of today's high-speed thermal processing and annealing lines three ways:

Construction—furnace layout compensates for thermal expansion. Maximum accessibility provided for convenient replacement of burner and heating element panels and rethreading.

Temperature Control—Typical examples are: proportioning-type controls to regulate recuperative radiant tubes in gas-fired furnaces; Furnatron® regulators to maintain constant temperatures in electric furnaces.

Atmosphere—Westinghouse atmosphere generators provide controlled and protective atmosphere which maintains product quality at higher speeds. Strip is produced flatter, more uniform . . . surface is cleaner.

Westinghouse consulting, application and design engineers can speed equipment installation, eliminate problems right from the start. They help match correct products to the job, test them to assure proper operation.

From planning or problem, to design, installation and start-up . . . Westinghouse is at your service. An experienced Westinghouse team will work with your engineering staff and consulting engineers in setting up your thermal process line.

For your convenience . . . 38 manufacturing and repair service plants superbly equipped for repairing all types of electric apparatus . . . 34 renewal parts warehouses strategically located in industrial centers, open 24 hours a day.

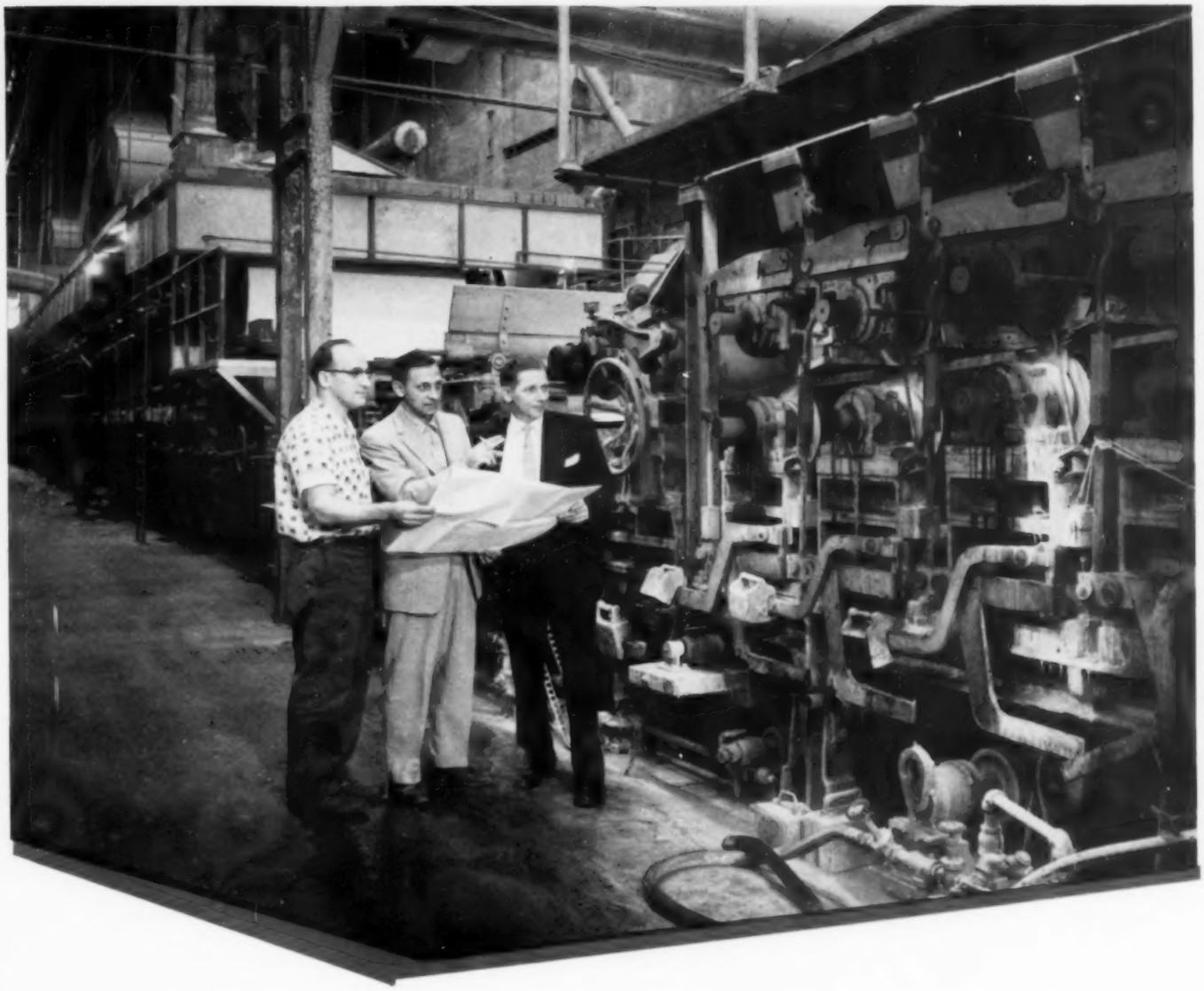
Contact your Westinghouse sales office for further details. Ask for a copy of B-6072, *Westinghouse Drives for Processing Lines.* Or write, Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. MP-3044

Completely self-adjusting, magnetic, d-c motor brake assures safer, more positive stops and starts. Maintenance and replacements minimized.

Westinghouse engineers help you plan installations like this compact a-c control center for fans, pumps and other auxiliary equipment.

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***



how Bearings, Inc. goes to work for its customers!

Here's service with a capital "S" as we see and practice it with the cooperation of our customers throughout *all* industry. Steel mills, foundries, mines, manufacturing plants. . . wherever bearings are used.

In the photograph are: left, B. H. Weideman, Millwright Foreman; J. A. Rupp, Maintenance Superintendent of the Ohio Boxboard Company plant at Rittman, Ohio, and the Bearings, Inc. salesmen, Jack Houser.

They are going over the final phases of a "bearing survey" Jack has been making for the company over the past six months. In this "survey" every bearing in every machine and pump in the Mill Division was located. The make, type, size and fit of over 4,000 anti-friction bearings was determined. The result of the "survey" has been very gratifying to plant executives. Information on every bearing is now at hand, instantly. Inventories of bearings are being steadily reduced and when the records show, to cite only one example, that 6 large, expensive bearings on 3 mills were identical except for a slight and unnecessary variation in internal fit, then no longer do they stock 4 replacements, 2 are plenty!

Do you need this kind of Bearings, Inc. service in your plant? We'll soon tell you. . . all you have to do is ask, no obligation of course.

Rendering bearing service in the territories adjacent to our branches, listed below.

BEARINGS, INC.

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Mansfield • Toledo • Youngstown • Zanesville
INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute
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WEST VIRGINIA: Charleston • Huntington • Wheeling
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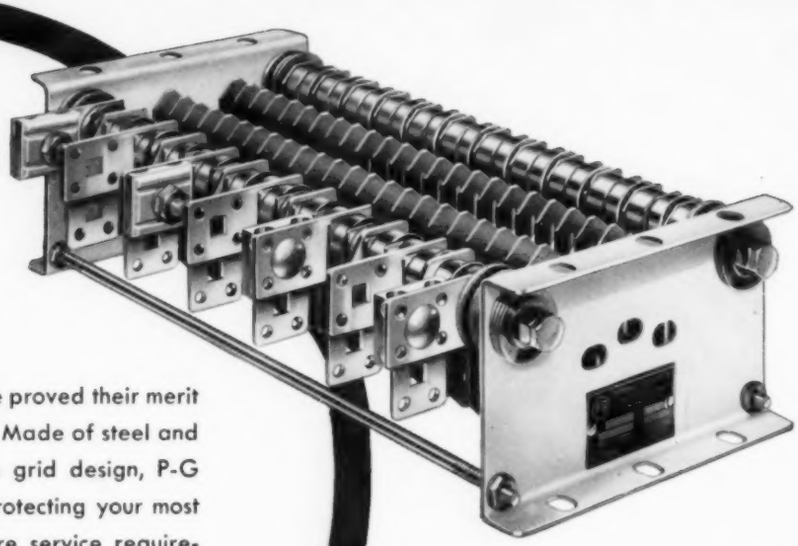


P-G STANDARD

Steel Grid Resistors

These rugged nonbreakable units have proved their merit in all kinds of service for many years. Made of steel and mica, plus P-G unique and exclusive grid design, P-G Standard Resistors are capable of protecting your most vital electrical equipment, even where service requirements are severe. Use of correct resistance value with ample capacity minimizes resistor trouble. ***Write for BULLETIN No. 500.***

P-G has BOTH!

P-G WELDED

Steel Grid Resistors

These units duplicate values of each P-G Standard Steel Grid Resistor. The only change is in adding welding links between resistance grids. Each welding link is made of the same alloy steel used for the grid. These links are heli-arc welded from grid to grid to create a continuous circuit without disruption to the normal path through contact spacers. Thus each P-G Welded Resistor has two paths available for carrying current. Naturally this offers double protection.

Write for BULLETIN No. 510.

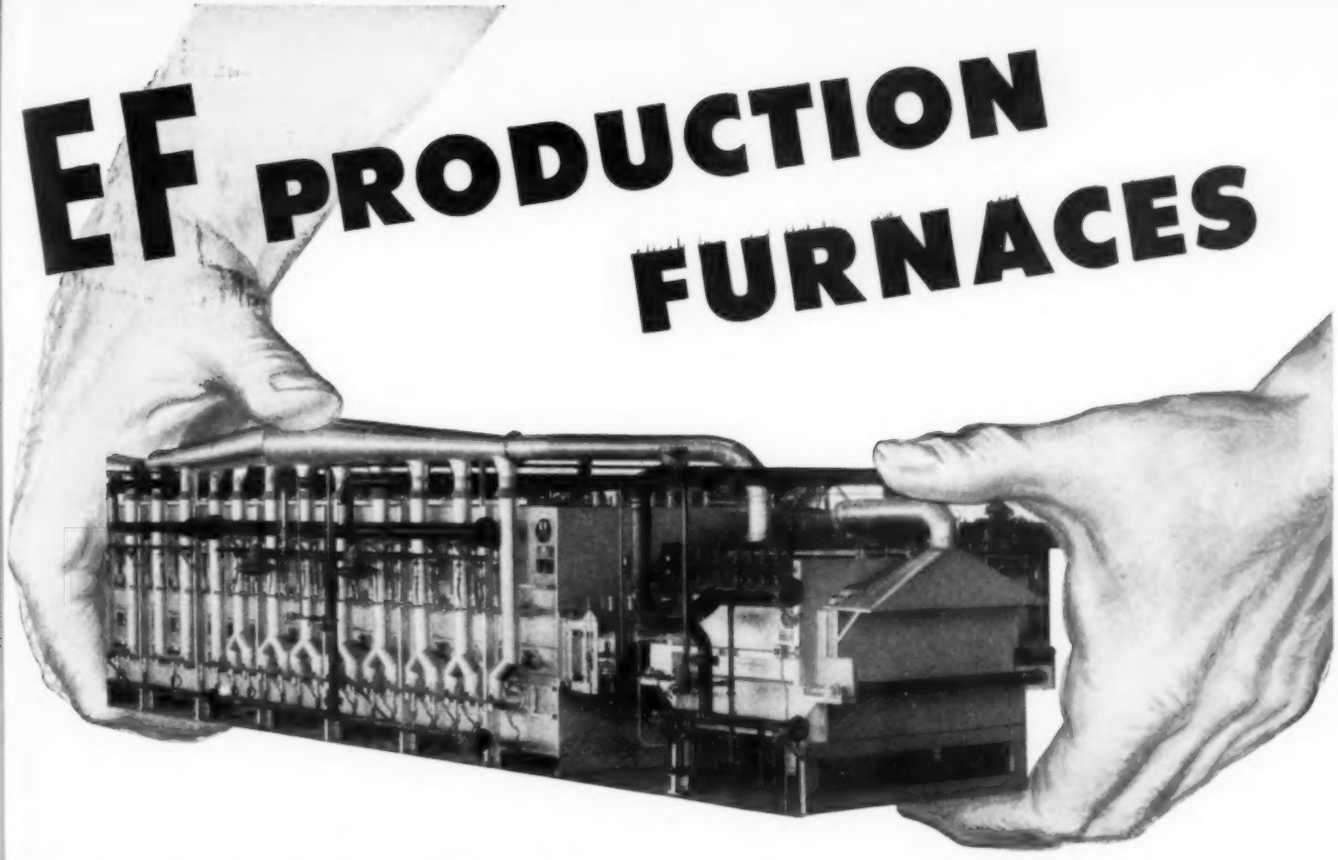
P-G

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

EF PRODUCTION FURNACES

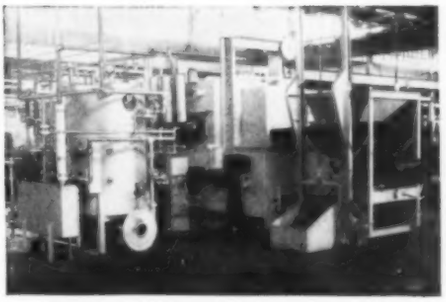


Designed, Built and Installed --- Ready to Produce

● It costs less to let experienced heat treating furnace engineers handle all phases of your heat processing furnace projects. Then you can be sure the design and type of furnace, the method of heating, the special atmosphere, the material handling and other equipment are all best suited for your particular product and process. All phases will be synchronized and coordinated to your production schedules, simplifying the entire operation and assuring profitable and trouble-free service.

EF engineers have served many of the country's most successful companies, and have handled many complete projects . . . some of extremely confidential nature.

On your next heat processing or furnace project, no matter how large or unusual, take advantage of the extensive experience and complete service offered by EF heat processing engineers — YOU'LL FIND IT PAYS.



A small, complete, compact installation consisting of an EF continuous scale-free hardening and gas carburizing furnace, a special combination endothermic and exothermic gas generator, automatic feeder, quench and discharge equipment.

A large combination gas fired and electrically heated continuous galvanizing furnace installation (over 300 feet long). As usual this equipment was completed and in production on schedule, and the first coil run thru was accepted as first class salable material.

THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

Salem - Ohio

Canadian Associates • Canefco Limited • Toronto 1, Canada

engineering teamwork plus

NBD DESIGN ANALYSIS

increases Tuyere life 10 times

for Wheeling Steel Corporation

The idea came from Wheeling Steel Corporation.

The engineering design came from NBD.

Teamwork between engineering departments made it possible.

The result: new, practical, longer lasting tuyeres, many with a service life of 300 days, 10 times the life of former designs.

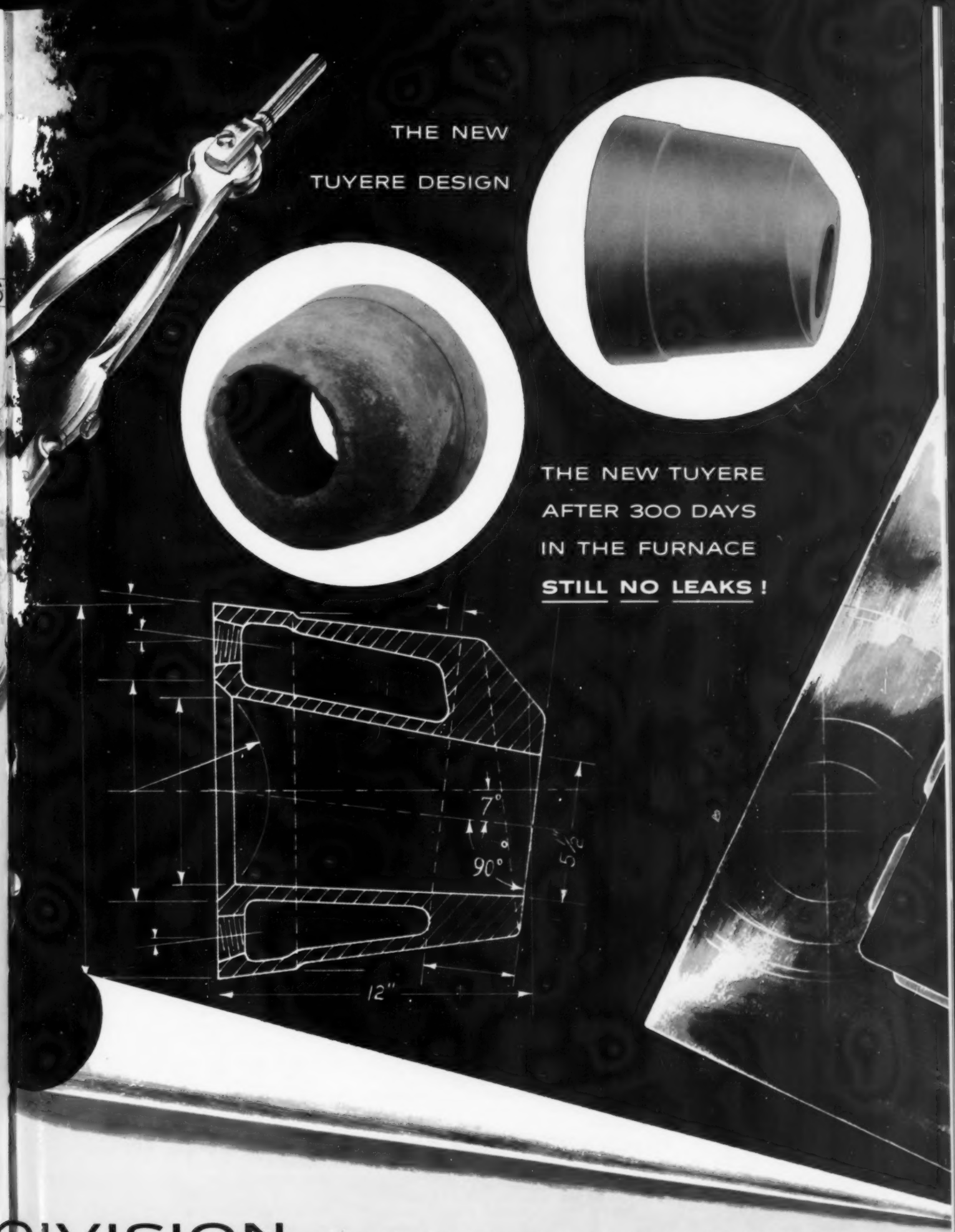
That's how NBD's more than 80 years of design and casting experience with blast furnace copper and bronze pays off. We call it Design Analysis—*where you use NBD's extensive engineering background, research and production facilities to prove ideas and make a design practical.*

Apply NBD Design Analysis to your problems with blast furnace copper and accessory equipment bronze parts. Call or write us to talk about it.

Calculate how much you would have saved, were this a case from your plant.

AMERICAN Brake Shoe COMPANY

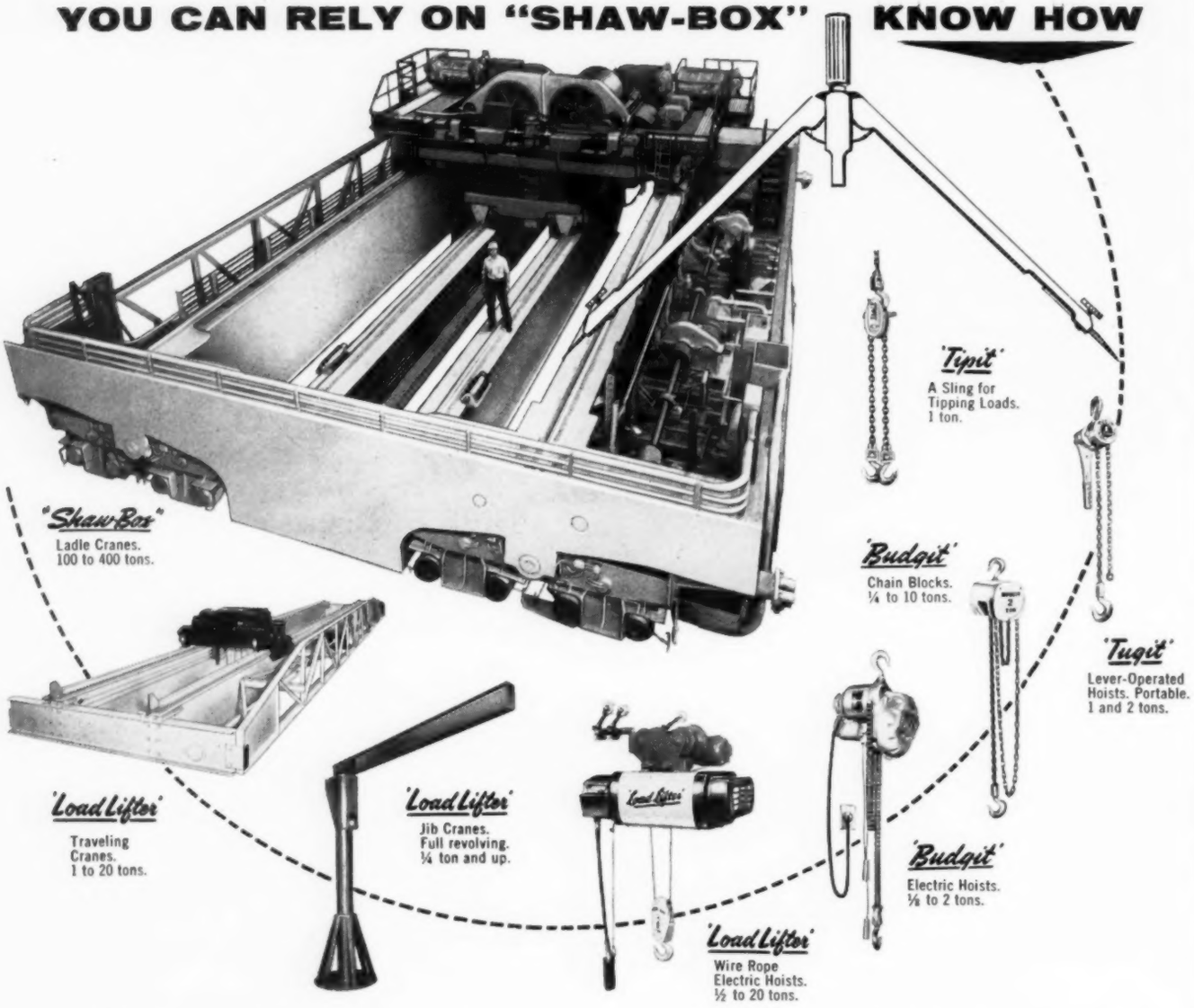
NATIONAL BEARINGS



IOIVISION 4930 Manchester Ave., St. Louis 10, Missouri
Box 458 Meadville, Pennsylvania

FOR GIANT CRANE OR SMALL HOIST

YOU CAN RELY ON "SHAW-BOX" KNOW HOW


'Tipit'
A Sling for Tipping Loads. 1 ton.
"Shaw-Box"
Ladle Cranes. 100 to 400 tons.
'Budgit'
Chain Blocks. ¼ to 10 tons.
'Tugit'
Lever-Operated Hoists. Portable. 1 and 2 tons.
'Load Lifter'
Traveling Cranes. 1 to 20 tons.
'Load Lifter'
Jib Cranes. Full revolving. ¼ ton and up.
'Budgit'
Electric Hoists. ½ to 2 tons.
'Load Lifter'
Wire Rope Electric Hoists. ½ to 20 tons.

Steel production and processing demand overhead load-handling equipment of many types and capacities. Whether it is a crane to handle molten steel or finished products, or a hoist to facilitate shipments or plant maintenance, complete dependability and highest performance are essential.

Mills everywhere have long benefited from "Shaw-Box" research, engineering and production facilities. The same kind of professional know-how that interprets crane requirements to AISE Specifications No. 6 or your own is engineered into all products bearing our brand names. You are assured of precision craftsmanship, top efficiency and economical service from our smallest hoists as well as our huge multi-motored cranes.

If you want to equip your mill with a new soaking pit carriage, a crane of any type or capacity or hoists for any purpose, your inquiry is invited.

"Shaw-Box" ® CRANES

57K-3

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION

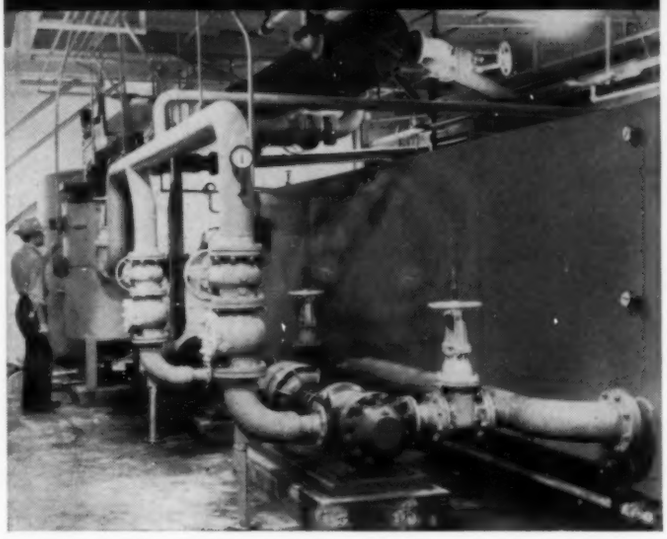
388 West Broadway • Muskegon, Michigan

Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Other Divisions produce 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments, and Aircraft Products.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Avenue Road, Galt, Ontario*

DRAVO-DELAVAL lubrication and coolant systems

Engineered Protection for Rolling Mill Machinery



Dravo-DeLaval Lubrication and Coolant systems are designed to circulate the right amount of lubricant at the right pressure and temperature to the right spot. Dravo Lubrication systems include these four fundamentals essential to efficient mill lubrication:

Streamline Flow

Piping, elbows and valves are carefully selected to hold pressure drops to a minimum and to provide non-turbulent flow.

Correct Metering of Lubricant

Dravo systems are designed to supply the right amount of lubricant needed at each lubrication point.

Temperature Control

Accurate, automatic temperature control is a feature of every Dravo system.

Efficient Filtering

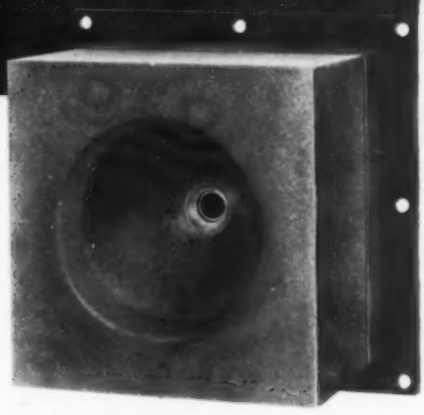
Full flow, pressure type filters allow an uninterrupted flow of clean lubricant with minimum pressure drop.

Dravo-DeLaval systems are custom designed to match customer requirements. For installations requiring up to 50 gpm, Dravo-DeLaval Unilube units offer compact, economical "packaged" lubrication systems. For complete details, write Dravo Corporation, Dravo Building, Pittsburgh 22, Pennsylvania.

DRAVO
CORPORATION

Special Lubrication and Coolant Systems for mechanical equipment serving industry

Large Radiant Heat Surface Provides High Rate of Heat Transfer

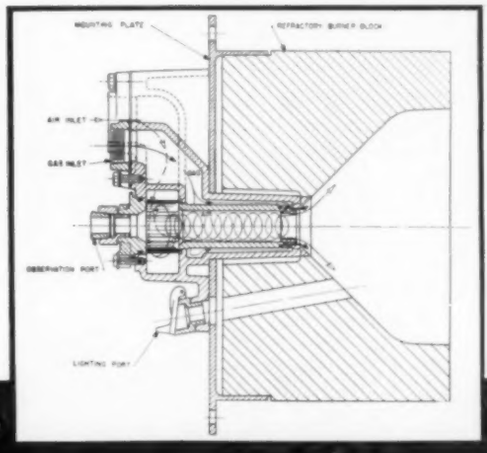


HAUCK Hi-Radiant Cone Gas Burner

Assures direct radiant heat processing for greater heat penetration without flame impingement

- Heating temperature to 2900° F.
- More than 10 to 1 turndown ratio
- Long, trouble-free performance
- Less burner maintenance
- Burner nozzle outlet of stainless steel
- Observation port
- Nozzle mixing of air and gas
- No backfiring, costly fire checks or mixers
- Uses low pressure air and gas
- Burns any fuel gas
- Reduces furnace size
- Six sizes— to 1.4 million Btu/Hr.

Write for Catalog 809



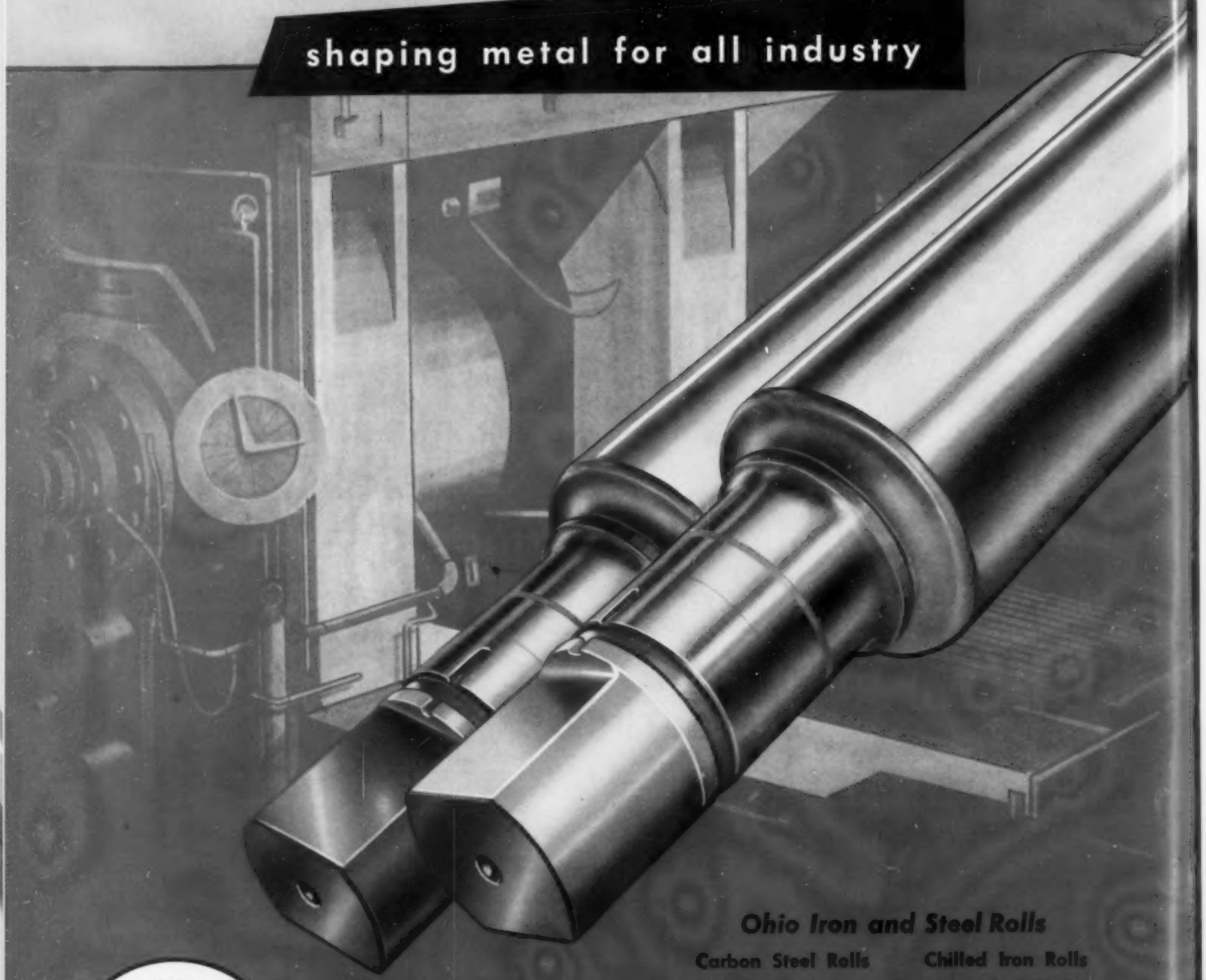
Series "RCG" Gas Burner for steel mill and non-ferrous heating furnaces.

Another in the extensive Hauck line of gas burners, oil burners, combination gas and oil burners, blowers, pumps and oil heaters.

HAUCK MANUFACTURING CO.
114-124 Tenth Street—Brooklyn 15, N. Y.

Ohio Rolls

shaping metal for all industry



Ohio Iron and Steel Rolls

Carbon Steel Rolls	Chilled Iron Rolls
Ohioloy Rolls	Denso Iron Rolls
Ohioloy "K" Rolls	Nickel Grain Rolls
Flintuff Rolls	Special Iron Rolls
Double-Pour Rolls	Nioloy Rolls
Forged Steel Rolls	

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1907
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THE OHIO STEEL FOUNDRY CO
LIMA, OHIO

Plants at Lima and Springfield, Ohio

OR11

Industry News...

ARMCO STEEL ANNOUNCES $50,000,000 EXPANSION PROGRAM AT ASHLAND AND HOUSTON PLANTS

▲ Armco Steel Corp. will spend $50 million to expand its Ashland, Ky., and Houston, Texas, plants, R. L. Gray, Armco president, has announced.

The main items to be constructed at Ashland are:

A new blast furnace with a 28 ft hearth which will have a capacity of 50,000 tons of pig iron per month.

Steel melting facilities with an annual capacity of 750,000 tons of ingots, part of which will be converted to slabs and shipped by barge on inland waterways to Armco's Sheffield Division plant at Houston.

Additional soaking pits and new finishing facilities.

At the Houston plant, a new heating furnace and other additions will be made to the 4-high plate mill there to permit the production of increased tonnages of wider and larger plates for the Southwestern market.

Construction of these facilities will begin as soon as the engineering work has been completed.

The addition of 750,000 tons will bring Armco's total ingot capacity to nearly 7 million tons by mid-1959.

OPENS NEW SLABBING AND BLOOMING MILL

▲ A new $14,000,000 slabbing and blooming mill, the largest capital expenditure program in Sharon Steel Corp.'s history, was opened February 8. The new facility increases ingot rolling at the works to 1,200,000 tons a year, and enables Sharon to process stainless and high alloy steels at Roemer for the first time.

Ingots weighing from four to 20 tons can now be rolled into slabs up to 10 in. thick by 60 in. wide by 30 ft long.

Quality control will be increased by the operation of two television screens at critical points in the rolling and handling of billets. One will be used by an operator to run an inter-mill connecting conveyor which carries ingots from an existing blooming mill to the new mill. A second screen will be watched by a pulpit operator as he controls the shearing passes.

An automatic "descarfing" machine which uses oxy-acetylene burning to clean defects from all four sides of a billet at once introduces another quality control feature.

Sharon has been a large producer of flat rolled narrow strip. Now, with the new blooming mill, the corporation will have rolling capacity to work much larger ingots into semi-finished steel. Stainless steel will be processed by twin 4000-hp driven rolls, specially designed for quick reversing and stopping under high speed. Each of the blooming rolls has its own 4,000 hp-dc motor.

The new rolling mill will absorb the increased furnace capacity resulting from the recent enlargement of three open-hearth furnaces to 250 tons each.

A second phase of Sharon's expansion was begun in January when construction got underway at the Roemer Works on a new electric furnace, which will double stainless capacity by early 1958.

QUEBEC IRON & TITANIUM EXPANDS AT SOREL

Production of titanium dioxide slag at Quebec Iron & Titanium Corp.'s Sorel, Quebec, Processing Plant will be increased 60 per cent with the addition of three new furnaces and auxiliary equipment. The entire expansion at Sorel (photo shows aerial view), which is expected to be completed by the beginning of 1959, will include a second dock and tower unloader and a speeded up conveyor system for handling additional ore tonnage.

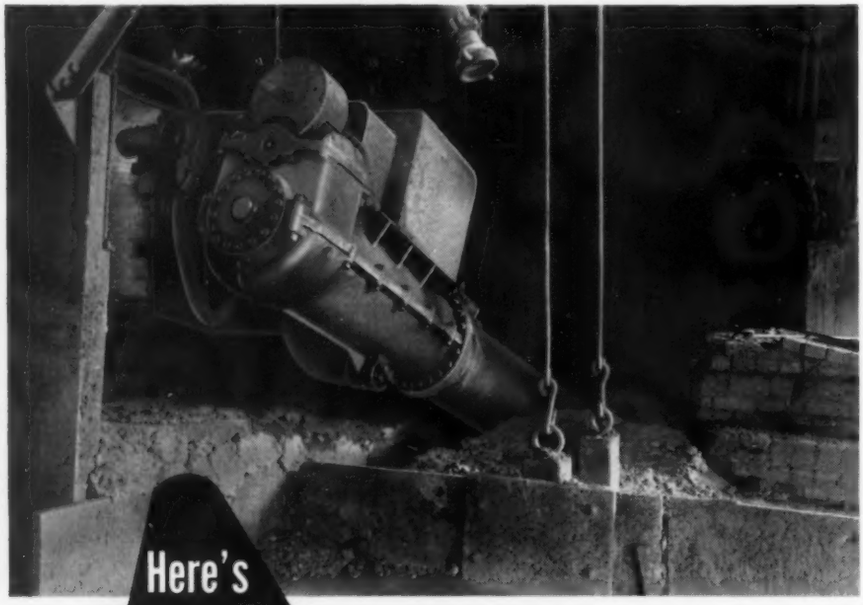
SHIPS CONTROLS FOR AUTOMATIC STEEL MILL

▲ The intelligence center for a new reversing roughing mill was shipped in February by the Westinghouse Electric Corp.'s motor and control division. Present plans call for the new mill to be in production at Jones and Laughlin's Aliquippa Works in mid-1957, as part of a major expansion program. The roughing mill will feed a six-stand continuous hot strip mill.

The shipment includes equipment for processing all operational data needed to roll any standard mill schedule. Drive and auxiliary equipment shipped earlier includes two 3000-hp motors for the main horizontal rolls and five mill motors rated from 50 to 375 horsepower.

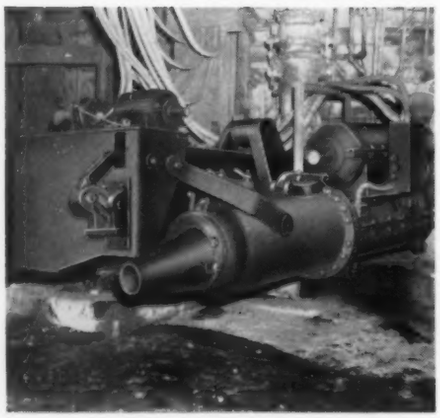
Applications of the new control system will not be confined to controlling roughing mills. Addi-

180 Bailey CLAY GUNS
IN CONTINUOUS SERVICE



Here's Why...

- Exceptional Power
- Accurately Controlled
- Operated by Three Separate Motors



With clay pressures of 600 psi, these guns provide ample power for plugging and maintaining long tapping holes. A unique mounting and operating system assures fast and accurate positioning with the ultimate in safety.

Bailey Electric Plunger Clay Guns are adaptable to both blast furnaces and large electric furnaces.

Write for Bulletin

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA

tional applications now under development include the automatic control of primary and secondary reversing mills for slabbing and blooming.

Westinghouse "Prodac" control systems for the steel industry control rolling schedules according to operating instructions punched into standard IBM cards. One card is adequate for an entire rolling schedule; it contains data to control mill screw-down opening, edger adjustment opening, mill speed, edger speed, and the number of passes to be made.

EQUIPMENT READY FOR EMPIRE ANNEALING LINE

▲ The Wean Engineering Co. has completed construction of equipment for a silicon strip continuous annealing line for Empire Steel Corp. The annealing line will handle strip steel having a maximum width of 42 in. and gage thickness varying from 0.052 in. to 0.014 in. and coil weights up to 30,000 lb.

The line is part of Empire Steel Corp.'s continuing program of improving their position in the industry, and the design includes standard coil handling equipment and electrolytic alkali cleaning prior to the annealing cycle. The annealing furnace is natural gas tube type firing, complete with protective gas generating equipment.

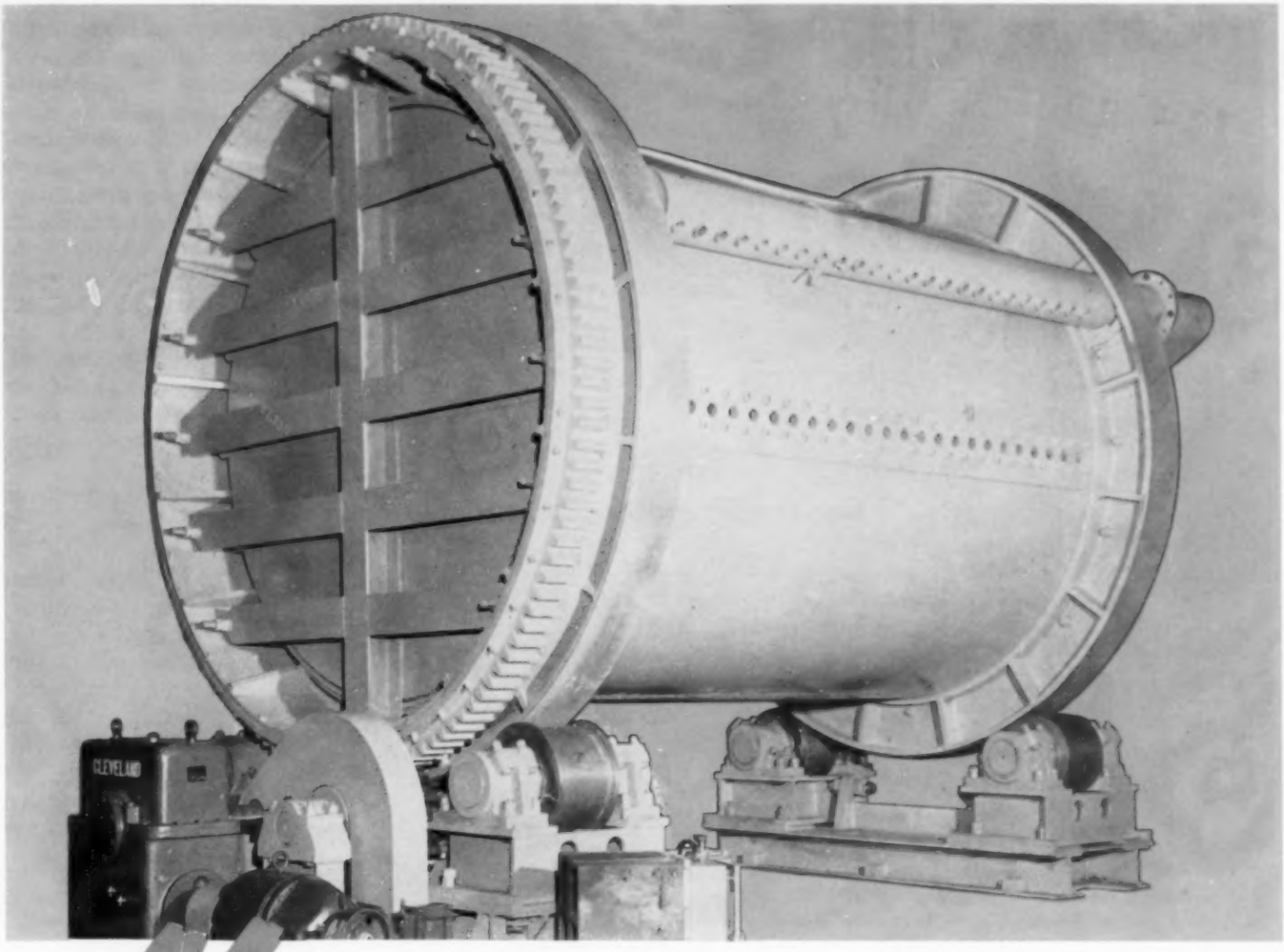
Wean has just completed three silicon steel continuous strip annealing lines in the Pittsburgh area and have under contract continuous strip tin plate annealing lines for Youngstown Sheet & Tube Co., Indiana Harbor Plant, and Kaiser Steel Corp., Fontana, Calif.

TO IMPROVE HANDLING FACILITIES AT DUQUESNE

▲ An improvement project covering facilities for handling raw materials and molten iron in the blast furnace department of United States Steel Corp.'s Duquesne Works was announced by Robert W. Graham, general superintendent.

Included in the project is the installation of a new railroad car dumper and a conveyor belt system to streamline the unloading and distribution of such raw materials as iron and manganese ores, sinter and limestone.

Also planned are new closed mixer



New copper converter

designed and fabricated by

Here's another product typical of PECor's advanced engineering—a high-efficiency Copper Converter—built to the rugged performance standards typical of PECor heavy equipment products. Nearly ten feet in diameter and 16 feet long, this big vessel presents advanced operating features and heavy duty construction that assures high production and minimum maintenance. For ahead-of-the-field engineering and top quality fabrication of large and heavy equipment—see PECor first!

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STEEL PLATE FABRICATORS ASSOCIATION

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PENNSYLVANIA ENGINEERING CORPORATION

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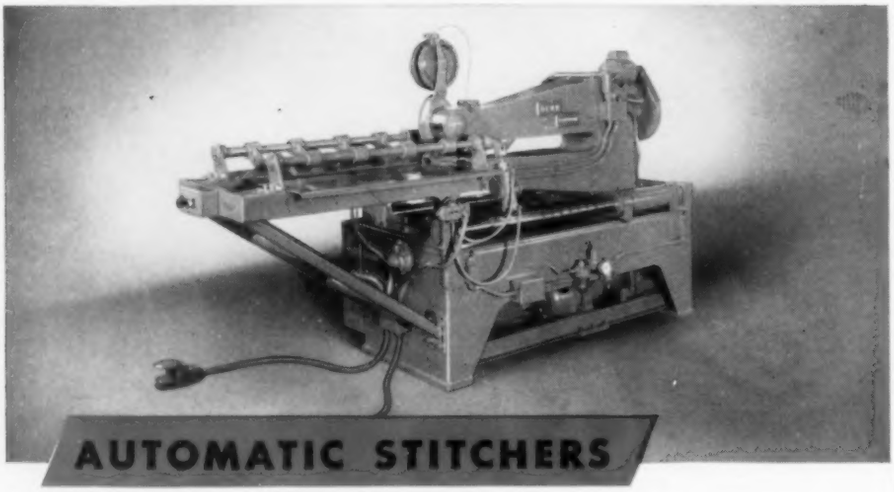
OTHER STEEL PLANT EQUIPMENT WE BUILD

BLAST FURNACES . . . SCRAP CARS . . . OPEN HEARTH FURNACES . . . SLAG CARS . . . OXYGEN CONVERTERS . . . HOT METAL MIXERS . . . ORE TRANSFER CARS . . . LADLES . . . JACK CARS . . . LADLE TRANSFER CARS . . . INGOT CARS . . . MIXER CARS . . . THERMO METAL (BOTTLE) CARS

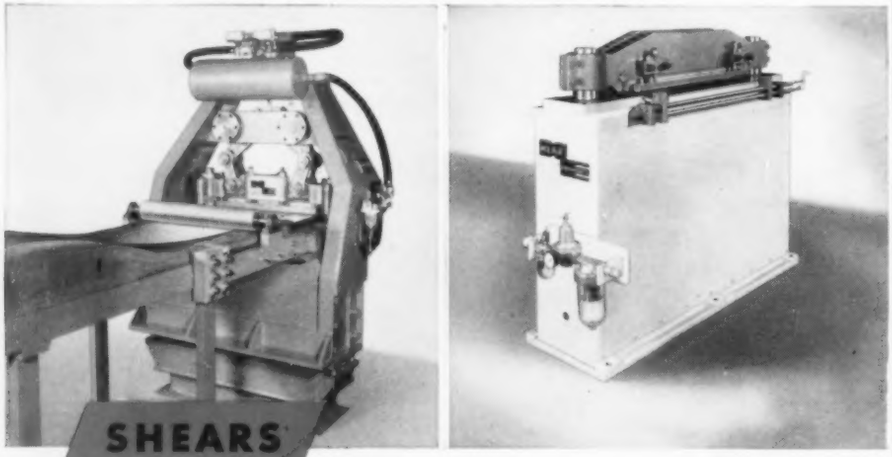
HERR EQUIPMENT

"Complete Processing and Handling Equipment . . . for any Ferrous or Non-Ferrous Material . . . That Starts — or Ends — as a Coil"



AUTOMATIC STITCHERS

Fast, dependable method of fastening the lead end of a new coil to the trailing end of a preceding coil. Entirely automatic. Produces a double row of locked stitches. Practical for strip of any width. Your samples stitched and returned promptly. Also automatic welders.



SHEARS

Fast acting single shears for use with hump tables in cut-to-length and press feed lines, and other applications to square crop the end of a coil. Also twin cut shears that remove the section where two coils were stitched or welded together for continuous processing.

Write for fully descriptive Bulletin No. 561 today!

THE HERR EQUIPMENT CORPORATION

1270 VINE STREET • WARREN, OHIO

CLEVELAND, INDIANAPOLIS AND BERKELEY, CALIFORNIA

ladles for transporting molten iron from the blast furnaces to open hearths. Capacity of the new ladles will be 175 net tons each, as compared to 35 tons each for those now in use.

The new unloading mechanism will double the number of railroad cars now processed each hour. A 48-in.-wide "v" belt will run more than one-half mile from the car dumper to the ore yard.

An intercommunication system linking the car dumper and the ore yard will help control the operation of travelling "trippers," which are designed to lift the belt to permit the material it is carrying to drop onto the proper stockpiles.

The new mixer ladles, similar to tank cars, are completely closed except for relatively small openings to admit and discharge the molten iron, thus eliminating most of the problems encountered with the faster cooling of metal in the old ladles, which are shaped like inverted bells.

The ladle program will require extensive work on railroad tracks within the Duquesne plant to take the heavier loads.

CONTINUOUS FURNACE ADDED AT MASSILLON

▲ Republic Steel Corp.'s Union Drawn Steel Division is increasing its productive capacity for carbon corrected annealed steels.

The installation of a fourth continuous carbon correction annealing furnace at the Union Drawn plant at Massillon, Ohio, will enable Union Drawn to give faster service on carbon corrected steels to present customers and supply new customers whose orders could not be handled previously.

Designed to specifications drawn by Union Drawn's chief metallurgist, J. D. Armour, the furnace in one continuous operation both anneals steel bars and restores to the surface of the bars carbon burnt out by previous hot working operations.

The new furnace will give the Massillon plant three continuous carbon correction furnaces for bars and one for coils. Union Drawn's Gary, Ind., plant also operates a furnace of this type for bars.

In addition to the continuous furnaces, Union Drawn operates three car-type carbon correction furnaces

at Massillon and three at Gary.

The installation of the new continuous furnace will increase annealing capacity at the Massillon plant sufficiently to enable Union Drawn to move one of the car-type furnaces at Massillon to the division's East Hartford, Conn., plant.

The new furnace is expected to be in operation by late 1957. Because of the additional steel stock necessary to service the furnace, an 11,000 sq ft addition will be built on the present stocking building.

DETROIT STEEL TAPS NEW OPEN HEARTH

▲ The first heat from a new 275-ton open hearth furnace at Detroit Steel Corp.'s Portsmouth, Ohio, plant was tapped February 23. This furnace is the fifth to be installed in the new No. 2 Shop since 1952, and like the others, was designed and built by Loftus Engineering Corp.

The new furnace is appreciably larger than the original four and is also equipped with full automatic control. It is significant that two pass checkers have been incorporated in the design, a feature which proved highly successful on the first four furnaces.

The checker arrangement is unique in that lancing is facilitated for the full depth of the settings in both passes. This was accomplished by extending the charging floor posts to the lower pad level throughout the building, thus providing substantial access to both sides of all regenerators.

OBTAINS OHIO PROPERTY FOR STAINLESS PLANT

▲ Options have been taken by Universal-Cyclops Steel Corp. on property for a new stainless steel plant site near Coshocton, Ohio. If all of the necessary land can be obtained, the property will consist of approximately 500 acres on the Muskingum River.

William G. Stewart, company president, described this move as a part of its long-term program of improvements and expansion which will also involve its existing plants at Bridgeville and Titusville, Pa.

He said: "A 30-in. wide stainless cold reduction mill with all the necessary auxiliary finishing facilities will be installed as the first step

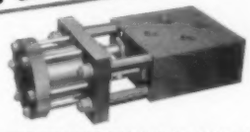
INEXPENSIVE—HIGHLY EFFICIENT

UNEQUALED FOR 1/8" AND 1/4" SERVICE

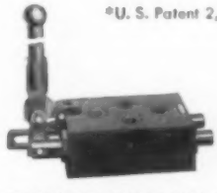
• These valves combine utmost simplicity, low price and rugged, efficient, dependable construction. Valve chambers* are formed by aluminum spacers held tightly in metal to metal end abutment assuring accurate positioning of the "O" rings on both inside and outside diameters without mechanical pressure. The flow is from the inlet chamber through the hollow radially ported ground and polished stainless steel plunger, and out through other ports in the plunger to the connected line. No direct impingement of flow across the packings. No lapped joints. No metal to metal seating. Sub-base permits 1/8" or 1/4" pipe connections into either side or bottom. Easily serviced in the field. Write for fully descriptive bulletin.

*U. S. Patent 2,645,450

Ask us also about . . .



PILOT CYLINDER OPERATED HYDRAULIC VALVES suited for use with water or hydraulic oils up to 5,000 psi. 2-way, 3-way and 4-way actions. Sizes 1/2" through 4".



LEVER OPERATED HYDRAULIC VALVES suited for use with water or hydraulic oils up to 5,000 psi. 2-way, 3-way and 4-way actions. Sizes 1/2" through 1 1/2".

Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1924 East Pershing St., Salem, Ohio

How perfectly simple —this Fast's Coupling with purely mechanical flexibility!

1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.
2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.
3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.
4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.
5. Sleeves, carried on bearing rings, located on transverse center line of hub spline faces (the load-carrying surfaces) . . . no crank action, no vibration.
6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3003 Scott Street, Baltimore 3, Maryland.

THE ORIGINAL **FAST'S Couplings**

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD.
This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans.
***Engineered* Products Sold with *Service*.**

in the building of a new stainless plant at this site. This equipment is designed to produce wider strip than is now possible on our present mills, and is planned to supplement our operations at Bridgeville. It is imperative that we meet competitive conditions in our industry and expand our potential markets. We hope to have these new facilities in operation by January 1, 1959."

The company has sought a new plant location because of geographical limitations at Bridgeville. However, it was emphasized that Universal-Cyclops will maintain its extensive operations as well as its general offices there. Present plans also call for expanding and improving facilities at the Titusville plant where considerable construction work is presently under way. The company is now building a $350,000 metallurgical laboratory there.

ANNOUNCES SOAKING PIT AND FURNACE ORDERS

▲ Salem-Brosius, Inc., announced that it has received an order to install two 3-hole rectangular soaking pits with recuperators at the Midland, Pa., Works of Crucible Steel Co. of America.

The soaking pits are similar to a previous installation at the Midland Works. They are scheduled for completion late in 1957 and will have a rated capacity of 288,000 tons per year.

Salem-Brosius also announced that Kaiser Aluminum & Chemical Corp. has placed an order for a large roller hearth type furnace for installation at Kaiser's new rolling mill in Ravenswood, W. Va.

The furnace measures 413 ft in length, with spray quench and the charge-discharge tables. It is a radiant-tube, convection heated furnace for heat treating aluminum alloy plate. A similar furnace is being installed by Salem-Brosius at Kaiser Aluminum's Spokane, Wash., plant.

SIGNS AGREEMENT TO MARKET OXYGEN GUN

▲ Signing of a world-wide agreement with The Steel Co. of Wales Limited to manufacture and promote the sale of the P. T. Oxygen Gun for open hearth steelmaking application has been announced by Kaiser Engineers Division of Henry J. Kaiser Co. Rights to make, use, sell and sublicense the patented equipment to others throughout the world, with the exception of Europe, are included in the agreement.

The oxygen gun was developed by The Steel Co. of Wales for speeding refinement of open hearth steel by the use of high purity oxygen. The company has used the gun at its Abbey works for the last two years in commercial operation of its ten open hearth furnaces. During this time, the apparatus and its application have proved to be a significant and measurable improvement in low-carbon steelmaking economy and quality.

Meetings

▲ The 7th National Materials Handling Exposition, will be held at Convention Hall, Philadelphia, Pa., April 29 through May 3.

Thirty-two speakers will address a conference conducted by the American Material Handling Society, April 30–May 2. On May 1, the society will hold its annual banquet at the Bellevue-Stratford Hotel.

▲ The Fortieth Annual Conference of the National Open Hearth Steel Committee in conjunction with the Annual Conference of the Blast Furnace, Coke Oven, and Raw Materials Committee of the American Institute of Mining, Metallurgical, and Petroleum Engineers will be held at the Penn-Sheraton Hotel, Pittsburgh, Pa., April 8–10.

▲ The Galvanizers Committee which is sponsored by the American Zinc Institute, will hold its 36th meeting on April 25–26, at the Drake Hotel, Chicago, Ill.

▲ The Eleventh Annual New England Regional Conference of the American Institute of Mining, Metallurgical, and Petroleum Engineers will be held May 17 and 18, at Hotel Statler, Boston, Mass.

▲ The American Zinc Institute, Inc., will hold its 39th Annual Meeting at the Drake Hotel, Chicago, Ill., April 25 and 26.

▲ The annual Conference on Instrumentation for the Iron and Steel Industry will be held March 26 and 27 at the Hotel Roosevelt, Pittsburgh, Pa.

Sponsor of the Conference is the Pittsburgh Section Instrument Society of America.

GENERAL REFRACTORIES

A COMPLETE REFRACTORIES SERVICE . . .

for the Steel Industry

OLIVE HILL BF and OLIVE HILL HI-FIRED brick rank high in any list of prominent and widely used brands of blast furnace refractories. Manufactured from dense-burning Kentucky flint fire clays by Grefco's unique manufacturing processes, OLIVE HILL brick set a standard for blast furnace refractory quality and workmanship.

Grefco processing of OLIVE HILL brick entails:

1. Careful selection, testing, stockpiling and blending of fire clays to insure uniform raw material quality.
2. Grinding and screening to prescribed formula to promote high density of product.
3. Efficient deairing during brick forming, also to promote density and proper physical structure.
4. Careful firing to exacting temperature schedules yields uniform high quality brick.
5. Close inspection of final product with gauging and sorting of brick to close size tolerance.
6. Quality control by statistical analysis procedures for the manufacturing processes.

In service, OLIVE HILL blast furnace brick, both BF and HI-FIRED, have produced many splendid performance records in the past. OLIVE HILL linings in presently operating furnaces, are giving outstanding performance and are more than meeting the increasing requirements of the expanding American Iron and Steel Industry.

GENERAL REFRACTORIES CO.
Philadelphia 2, Pa.

From one source . . . any instrumentation you need

When it comes to measurement and control, every industrial process is different. Each demands its own combination of accuracy, economy, instrument ranges and all the numerous other characteristics that are peculiar to the individual application.

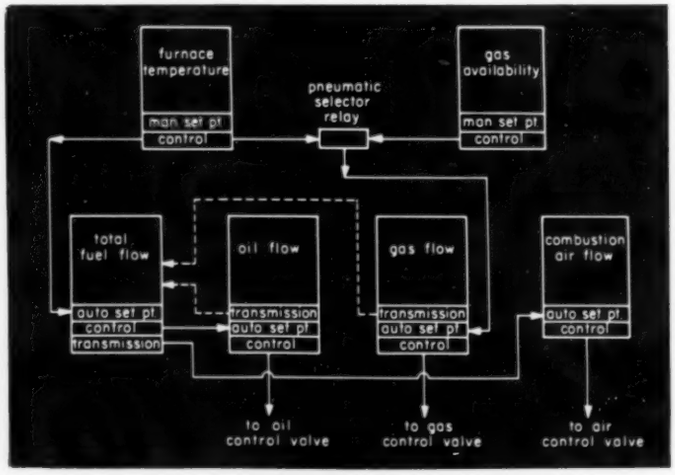
No single instrument and its accessories could possibly fit every process. So Honeywell makes a broad variety of measuring and controlling equipment that spreads across a tremendous range of applications.

The advantages are two-fold. First, you can get all the instrumentation your process requires from a single source, so there is undivided responsibility for the complete installation. And second, you are assured that the equipment selected for your process is recommended without bias . . . neither over-sells nor under-equips . . . needs no stretching, squeezing or compromising to fit it to its assignment.

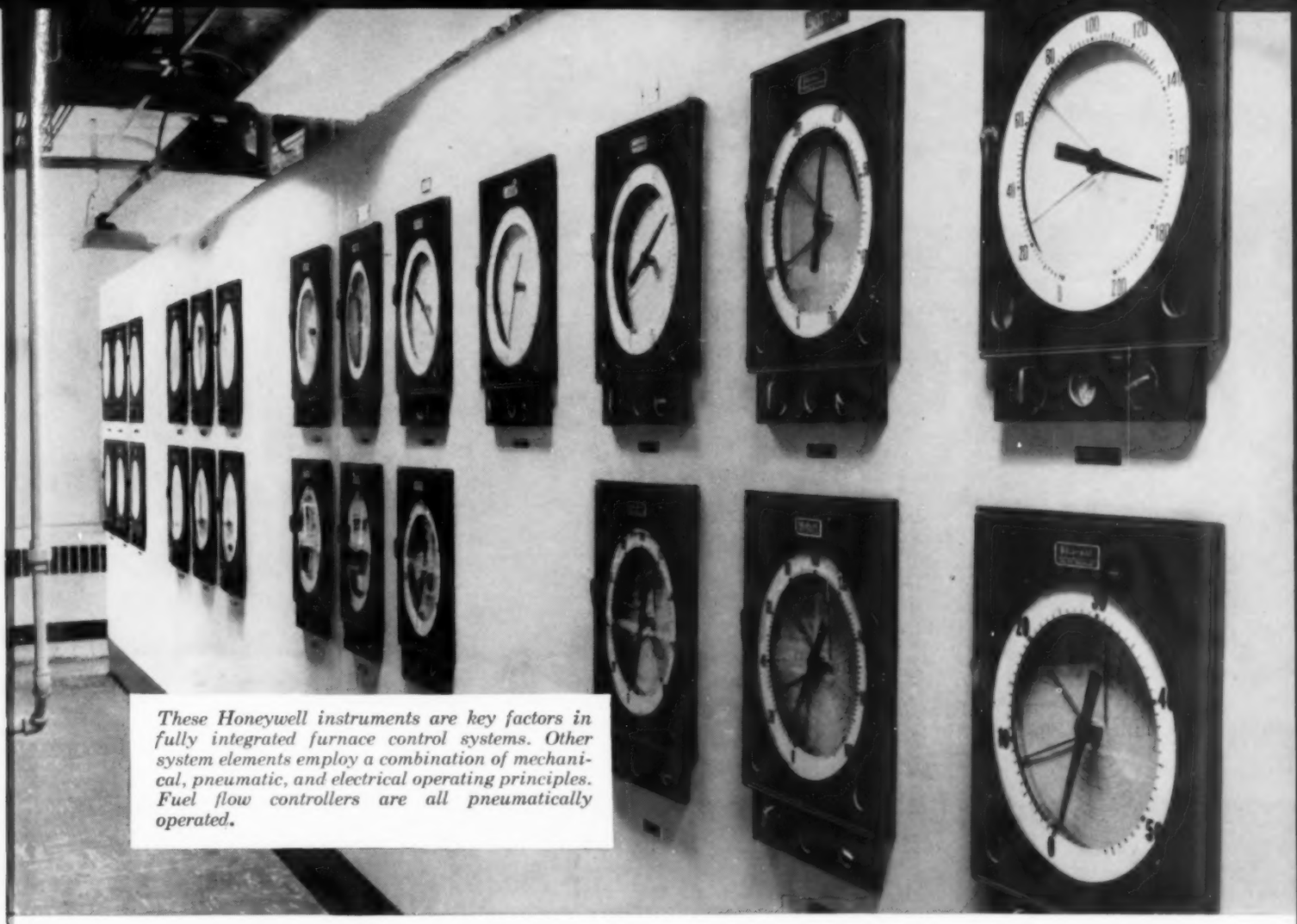
This versatile family includes *ElectroniK* indicators, recorders and controllers in circular and strip chart models, applicable to temperature, pressure, pH, power and dozens of other variables; square root flow meters for control applications; evenly graduated flow meters for cost accounting; thermometers, pressure gages and liquid level meters; *Pyr-O-Vane* millivoltmeter controllers. Especially useful for graphic panels are the *Tel-O-Set* miniature indicators, recorders and controllers. Electric and pneumatic control systems range from the simplest to the most complex, including automatic program controls and complete systems developed for particular processes.

Working with these instruments is a full choice of primary elements . . . thermocouples, *Radiamatic* radiation elements, pressure-type and electrical resistance thermal systems, flow meter bodies, pH cells and many others. For final control elements, you can choose from a wide range of electric motorized and diaphragm operated valves. To complete the picture, there are more than 7000 non-indicating devices for controlling temperature, pressure, vacuum, liquid level and humidity . . . an unmatched variety of instrumentation made by the world's largest manufacturer of control equipment.

Honeywell-engineered reheating furnace control system . . .



Control system for triple-fired, three-zone slab reheating furnace.



These Honeywell instruments are key factors in fully integrated furnace control systems. Other system elements employ a combination of mechanical, pneumatic, and electrical operating principles. Fuel flow controllers are all pneumatically operated.

puts byproduct gas to work

A large Eastern steel mill was faced with the problem of how to economically use its large quantities of byproduct gas fuels. A Honeywell-engineered control system provided the economical solution. The system puts byproduct gas fuel to work on the basis of its availability, automatically adjusting the combustion system as required. It adds the right amount of oil fuel to gas to make up the total fuel demand. And it maintains correct fuel-air ratios, automatically, under all firing conditions.

Manual control of furnaces was exceedingly difficult for two reasons. First, much of the gas was fed to multiple-fuel reheating furnaces, and surplus gas often varied widely and rapidly in availability. And second, fuel oil was used to make up the difference between furnace fuel demand and available byproduct gas fuel. Simultaneous balancing of the quantity of each fuel was needed to satisfy temperature and load demands of reheating furnaces.

Time that used to be spent coping with fuel problems now is concentrated on furnace operation and product quality. Personnel training and trouble-shooting have been simplified by the use of instruments of familiar design and construction. Maintenance of the complete interlocked control system, even in this steel mill environment, is no greater than that required for single instruments.

In your own plant, instrumentation by Honeywell can lead directly to important economies and upgraded product quality. Your nearby Honeywell sales engineer can give you the facts and figures . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

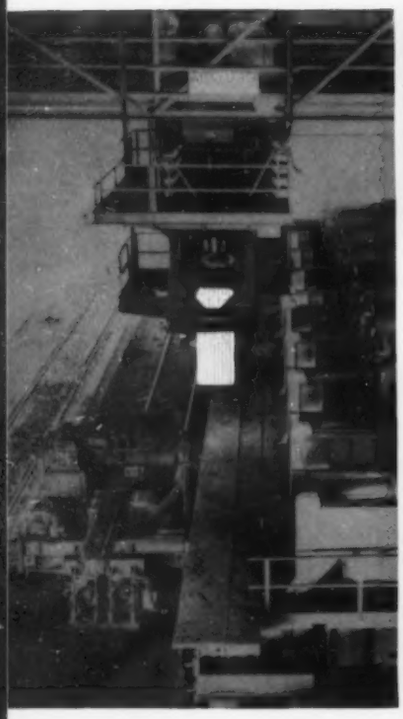
H HONEYWELL

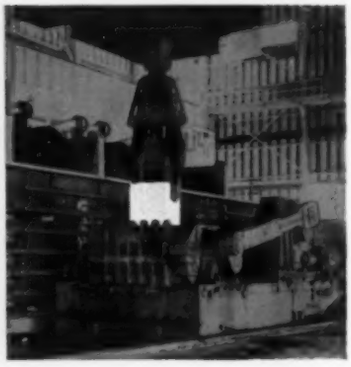
MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

READY





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TO ROLL

New batteries of Surface® one-way fired soaking pits go into operation in Texas, where men make big investments and expect big returns

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Benno Schilde Maschinenbau, A. G., Bad Hersfeld

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STEEL MILL EQUIPMENT

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NATIONAL BRUSHES
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for Industrial Truck Motors

Lower maintenance costs and longer service life for expensive equipment — that's why manufacturers and users specify "National" brushes for their industrial truck applications: traction motors, lift hoist and hydraulic pump motors. "National" brushes can be depended on to deliver superior performance under the most rugged service conditions.

FOR HEAVY DUTY . . . . . GRADE 549

FOR LESS SEVERE CONDITIONS . . . . . GRADE N1

For specialized advice on any brush performance or specification problem, call on NATIONAL CARBON COMPANY.

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NATIONAL CARBON COMPANY • A Division of Union Carbide and Carbon Corporation • 30 East 42nd Street, New York 17, N. Y.

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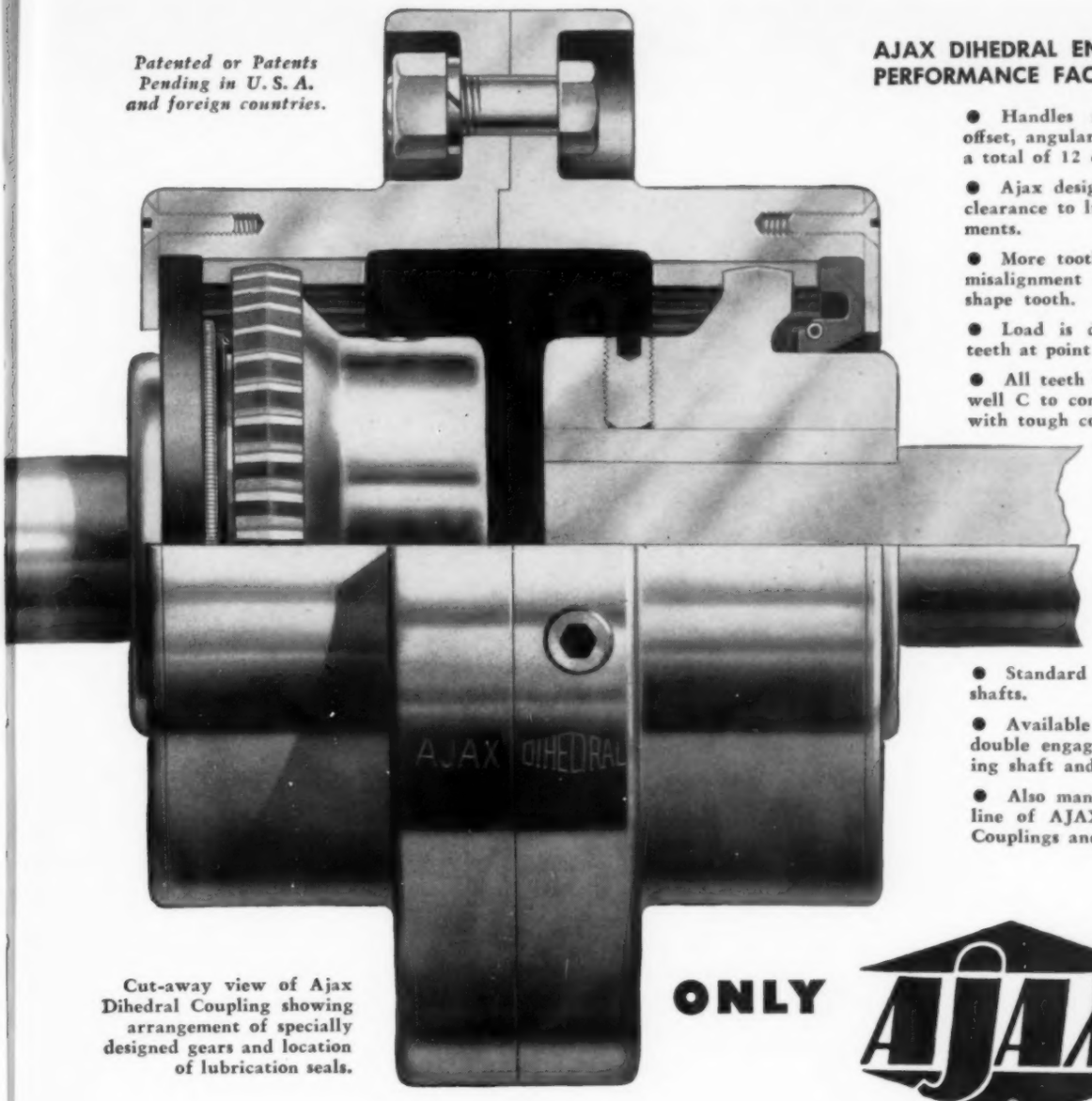

Cut-away view of Ajax Dihedral Coupling showing arrangement of specially designed gears and location of lubrication seals.

AJAX DIHEDRAL ENGINEERING AND PERFORMANCE FACTS

- Handles shaft misalignment, — offset, angular and end float — up to a total of 12 degrees.
- Ajax design permits holding tooth clearance to lubrication space requirements.
- More tooth area in contact under misalignment than with any other shape tooth.
- Load is distributed at center of teeth at point of greatest strength.
- All teeth hardened to 50-55 Rockwell C to combine hard wear surface with tough core.
- Seals keep lubricant in and dirt out.
- Constant angular velocity.
- No end-of-tooth contact even under maximum misalignment.
- Free end float.
- Standard sizes to fit ½" to 11" shafts.
- Available in regular single and double engagement, mill motor, floating shaft and spindle shaft types.
- Also manufacturers of a complete line of AJAX Rubber-Bronze Bushed Couplings and Vibrating Conveyors.

ONLY AJAX

DIHEDRAL COUPLINGS PUBLISH THEIR MISALIGNMENT CAPACITIES

MAXIMUM PARALLEL-OFFSET CAPACITY FOR COUPLINGS DESIGNED TO ACCOMMODATE ANGULAR MISALIGNMENT AS SHOWN IN TABLE*

Coupling Size	Distance Between Center Lines of Hub Gears	ANGULAR MISALIGNMENT CAPACITY OF COUPLING 4°	7°	12°
150	2⅝"	.092	.160	.263
200	3 5/16"	.116	.202	.335
250	3¾"	.131	.229	.380
300	4½"	.157	.275	.452
350	5 1/16"	.177	.309	.498
400	5 9/16"	.194	.339	.551
450	6⅛"	.214	.374	.604
500	6¾"	.236	.412	.651
550	7⅞"	.275	.480	.781
600	9"	.314	.549	.899
700	10 1/16"	.351	.614	1.004

* For double engagement Dihedral Couplings only. Angular capacity is reduced to zero (0) when full parallel-offset condition exists.

Ajax misalignment capacities are cataloged so that engineers can design misalignment into as well as out of the machines they build. Ajax Dihedral Couplings make possible design improvements based on ability to handle misalignment heretofore impossible with conventional couplings.

In addition, they are providing constant angular velocity which results in better performance, better product quality and greatly increased output speeds under severest conditions of heavy loads and high horse powers.

The revolutionary design and performance characteristics of Ajax Dihedral Couplings are worth looking into. Correspondence is invited and the personal service and attention of the Ajax application man is as near as your telephone. Write today for your personal copy of Bulletin No. 62A.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, N. Y.
Representatives in Principal Cities
The World's Most Complete Line of Flexible Couplings

Here's what steel Kaiser

COMPARATIVE ENDWALL TRIAL "... had inspected walls day prior to accident and noted Kaiser Periclase Chrome Metal Encased Brick sections were plumb, in line and tight whereas competitive sections were bowed and leaking."

BACKWALLS "... having tremendous success with Kaiser Chrome Periclase Brick in backwalls ... on rebuild, gave instructions to leave it in for another campaign."

HOT TAP HOLES "... averaging between 20 and 25 heats with Permanente 165 on the 300-ton furnaces, where competitive mix previously gave 3 to 5 heats."

ENDWALLS "... Panels of Kaiser Periclase Chrome Metal Encased Brick went 402 heats while competitive panels in the same campaign were replaced at 265 heats."

BOTTOM PERFORMANCE "... Permanente 165 bottom has tapped 413 heats with delay figure of 3 minutes while competitive bottom - rammed five days earlier - has tapped only 360 heats with an average delay figure over bogey of 11 minutes."

ENDWALLS "... Furnace finished its third campaign using Kaiser Periclase Chrome Brick endwall for a total of 562 heats. Other furnaces using competitive brick usually lasted only 200 heats - one campaign."

industry users are saying about Basic Refractories

One of the most significant things about these statements from Kaiser Chemicals customers is that each of them illustrates a *new performance or production record* made possible by changing to a Kaiser Chemicals basic refractory product.

Why this uniform superiority?

Kaiser Chemicals refractories are *especially designed* for peak performance in specific applications in open hearth and electric steel furnaces. Each is a specially-developed composition . . . each is backed by more than 15 years of continuous research and development.

The uniform composition of Kaiser Chemicals refractories—your guarantee of dependability—is assured by Kaiser Chemicals fully-integrated facilities, controlling quality from initial production of sea water magnesia to assistance in final installation at your mill.

Call or write Kaiser Chemicals Division, Dept. S7441, Kaiser Aluminum & Chemical Sales, Inc., at any of the addresses listed below.

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OAKLAND 12, CALIF. . . . . 1924 Broadway

KAISER CHEMICALS BASIC REFRACTORIES FOR THE STEEL INDUSTRY:

Kaiser **PERICLASE** Brick (D-S)
Kaiser **PERICLASE-CHROME** Brick
Kaiser **CHROME-PERICLASE** Brick
Permanente 165 Ramming Mix
Permanente 84 Ramming Mix

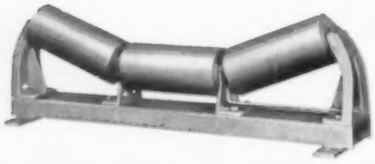
Kaiser Chemicals

Pioneers in Modern Basic Refractories

REFRACTORY BRICK & RAMMING MATERIALS • CASTABLES & MORTARS
MAGNESITE • PERICLASE • DEADBURNED DOLOMITE • ALUMINAS

MATCH IDLERS TO THE JOB

...LINK-BELT can meet your specific load and capacity requirements

IDLER SERIES	TYPE OF IDLER DUTY	TYPICAL APPLICATIONS
NEW 50	General duty conveyor • for maximum loads of 100 lbs. per cubic foot • for moderate lump sizes	Designed for conveyors carrying medium loads or for installations requiring intermittent operation.
100	"Round-the-clock work horse" • handles all but the heaviest and coarsest materials	Coal, coke, sand, gravel, iron ores, sinter, taconite, potash.
200 	Rugged heavyweight • for continuous service • carries the heaviest and coarsest materials	Heavy ores, such as iron, copper, etc. . . . on conveyors employing high-capacity belts.

LINK-BELT SERIES 100 IDLERS on this 42-in. wide, 218-ft. long belt conveyor carry 800 tph of ore from primary screens to stock pile.

TO TRAIN YOUR BELTS for proper operation . . .

BELT TRAINING IDLERS Left, positive action type trains and protects single direction belts. Actuating disc type at right is best for reversible conveyors. Self-aligning idlers of both types are also available for return run.

RETURN BELT IDLERS support the empty belt on the return run.

TO PROTECT THEM IN SERVICE

TROUGHED RUBBER CUSHION IDLERS (right) absorb impact under loading points, when large lumps and heavy materials are loaded on belt. Rubber tread return idlers, at left, simplify handling of tenacious materials.

WHETHER you handle cottonseed or coal—Link-Belt makes the exact size and type of belt conveyor idler you need. For top performance . . . lowest per-ton handling cost—see your nearby Link-Belt office or authorized stock-carrying distributor. Ask for Data Book 2416.

LINK-BELT

BELT CONVEYOR IDLERS

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Personnel News...

Donald C. Osborne has been named assistant general superintendent in charge of rolling and processing at Armco Steel Corp.'s Middletown Works. **Robert S. Hayes** will assume the position of assistant general superintendent supervising maintenance and services. In addition, **Vernon W. Jones** has been appointed assistant general superintendent heading up blast furnace and steel plant operations at Middletown, and **John Poast** has been promoted to assistant general superintendent in charge of the Hamilton plant of the Middletown Works.

Mr. Osborne joined Armco in 1933 and held a wide variety of positions in the processing, combustion, and engineering departments. In 1941, he became assistant to the superintendent of the east processing department. He became superintendent of the east processing department in 1946, and six years later was transferred to the personal relations division as supervisor. In 1955, he was placed on special assignment and last year became assistant to the general superintendent, the position he held until his recent promotion. Mr. Hayes began his Armco career in 1912 in the sheet mill department. In 1931 he was transferred to the blooming, bar, and strip mill as general foreman. When the cold strip mill department was built in 1936, he was named superintendent. In 1948, he was appointed superintendent of the maintenance department and continued in that assignment until the present.

Mr. Jones joined Armco in 1928, and was assigned to the open hearth department as a melter. He progressed through the positions of general foreman, assistant to the superintendent, and assistant superintendent. In 1943, he was named superintendent of the open hearth department and in 1950 became superintendent in charge of steel plant production. He has held that position for the past six years. Mr. Poast began at Armco in 1933. In 1934 he was transferred to the metallurgical department as an analyst. He performed a variety of assignments there and in 1940 was promoted to junior metallurgist at Armco's Hamilton plant. In 1946 he became assistant to the blast furnace superintendent at the Hamilton plant. Later that year he was appointed assistant superintendent and in 1948 was promoted to superintendent. In 1952, he was transferred to the new Middletown blast furnace as superintendent. He remained in that assignment until his recent promotion.

James O. Light, formerly superintendent, open hearth and foundry department, was named division superintendent, Lower Works operations at Lorain Works, National Tube Division, U. S. Steel Corp. Mr. Light was first employed at Lorain Works in 1936 and was promoted to the position of assistant chief metallurgist in 1943. He was advanced to the position of chief metallurgist, 1948; assistant to the general superintendent, 1950; and superintendent, open hearth and foundry department, in 1952. In other appointments, **Luis Sanchez** was promoted from superintendent, bessemer department, to superintendent, open hearth and foundry department, succeeding Mr. Light. **Richard C. Dierker** was advanced to the position of superintendent, bessemer department, succeeding Mr. Sanchez. He was previously assistant superintendent. **Edwin F. Beckwith** was appointed to the position of assistant chief engineer succeeding **George R. Farley,** who died January 5. **Andrew C. Cooper** was promoted from his position of assistant superintendent to superintendent, roll and tool shops, succeeding Mr. Beckwith.

C. S. Mushinski was named superintendent-bar products, and **J. E. Nordheim** became superintendent-flat rolled products at Crucible Steel Co. of America's Park Works. Mr. Mushinski formerly was superintendent in charge of annealing, heat treating, and bar finishing. Mr. Nordheim formerly was superintendent of sheet mills.

Carl F. Norbeck was appointed superintendent of the Open Hearth Division of Bethlehem Steel Co's Lackawanna, N. Y., plant. Mr. Norbeck, assistant superintendent of the division for the past year, succeeds **Joseph L. Walton,** who has been appointed an assistant general manager of Bethlehem's Johnstown, Pa. plant. **Robert M. Jordan,** No. 1 open hearth superintendent at Lackawanna, was named assistant superintendent of the Open Hearth Division. New superintendent of No. 1 open hearth will be **Frank G. Greg-**

D. C. OSBORNE

R. S. HAYES

V. W. JONES

JOHN POAST

C. F. NORBECK

R. M. JORDAN

C. G. HOGBERG

J. F. FRAIN

ory, transferred from the superintendency of No. 3 open hearth. **Norman W. Fennie,** assistant to superintendent of No. 3 open hearth for six years, was made superintendent of No. 3. Succeeding him as assistant to superintendent will be **Emil A. Axelson,** assistant general foreman of the mold yard since 1953.

Carl G. Hogberg has been appointed vice president of Michigan Limestone Division, U. S. Steel Corp. Mr. Hogberg began his employment with U. S. Steel as a blast furnace apprentice at South Chicago Works in 1935. He was transferred to Pittsburgh in 1941, where he was primarily associated with blast furnace raw materials development and quality control problems in their production on U. S. Steel's operating committees. Mr. Hogberg came to Detroit in June, 1955, as assistant to vice president of Michigan Limestone Division, receiving promotion to assistant vice president the following year.

J. Frank Frain has been appointed to the position of principal engineer of Kaiser Engineers Division of Henry J. Kaiser Co. Mr. Frain's activities will pertain primarily to the steel industry in which he has a background of some 35 years of experience. He will report to **E. T. Larsen,** vice president of engineering. For the past ten years, Mr. Frain has been a consulting engineer in Latin America. In Argentina and Brazil he furnished manufacturing and technical guidance to steel plants. During this time, he also supervised the installation and initial operations of an electric resistant weld pipe plant in Argentina. In addition to this he originated complete engineering plans to determine the economic feasibility of building electric furnace specialty steel-making plants in Argentina as well as in Brazil. Previously he was superintendent of rolling mills, Carnegie-Illinois Steel Co., at Gary, Ind., and before that he was general superintendent, Babcock Wilcox Tube Co., Beaver Falls, Pa., and assistant pipe mill superintendent, National Tube Co., Gary, Ind.

J. Frederic Byers, Jr., former president of A. M. Byers Co. and a director since 1939, was elected chairman of the board. At the same time, **B. M. Byers,** also a director, was elected president of the company to succeed his brother. B. M. Byers has been vice president in charge of sales since 1953. The post of chairman has been vacant since 1949.

Harry E. Hogue has been appointed assistant manager of operations of Sharon Steel Corp.'s Dearborn Division.

Dr. Harold M. McCullough has joined the Research and Development Department as research associate of the Universal-Cyclops Steel Corp. Dr. McCullough was previously employed with Sylvania Electric Products Inc.

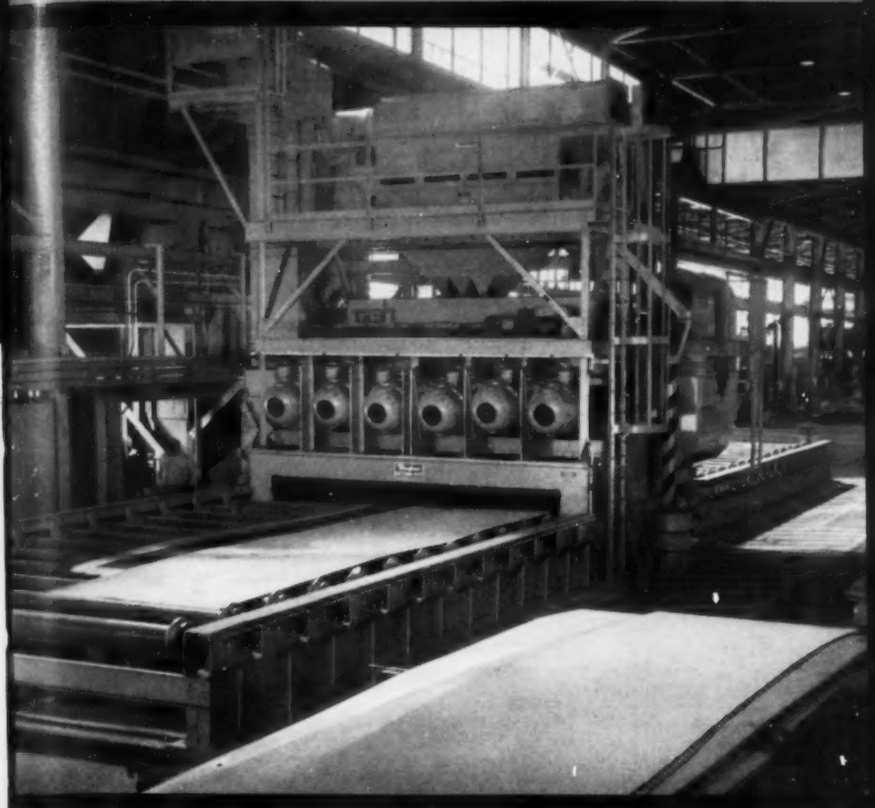
Earl A. Neeb, formerly general superintendent of hot rolling and slab conditioning, Brackenridge Works, Allegheny Ludlum Steel Corp., has been appointed plant manager of the Toronto, Ohio, plant of the Titanium Metals Corp. of America. Mr. Neeb first worked

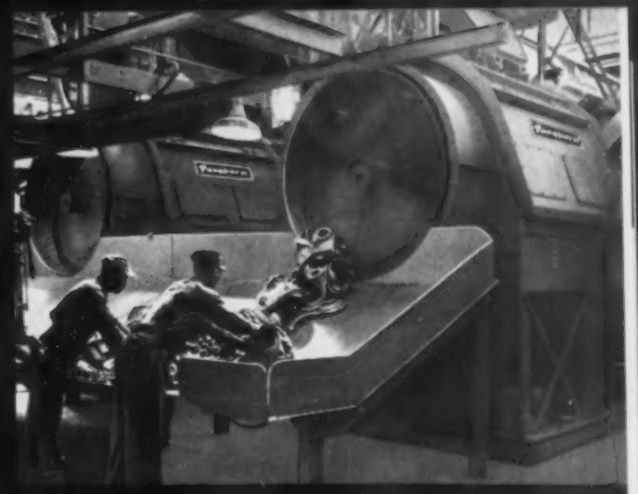
E. A. NEEB

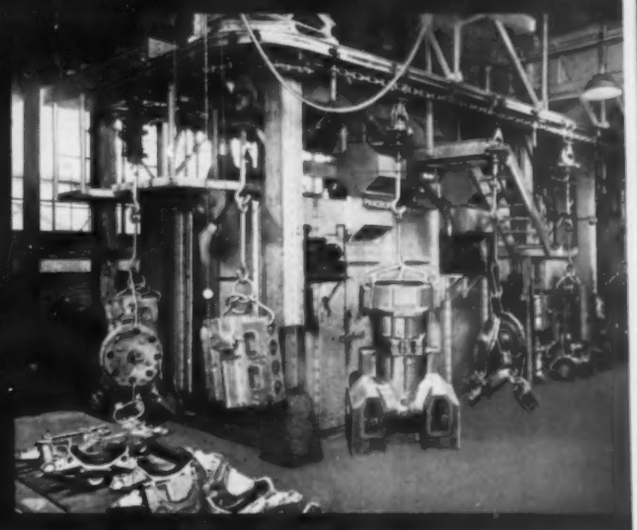
for Bethlehem Steel Corp. as superintendent of the Franklin plant, and joined Allegheny Ludlum in 1949 as plant engineer, Brackenridge Works. He progressively moved through superintendent and manager of the blooming and hot-strip departments to general superintendent of hot rolling and slab conditioning.

Stephen H. Van Syke has been appointed superintendent of the Elyria plant of the Pressed Steel

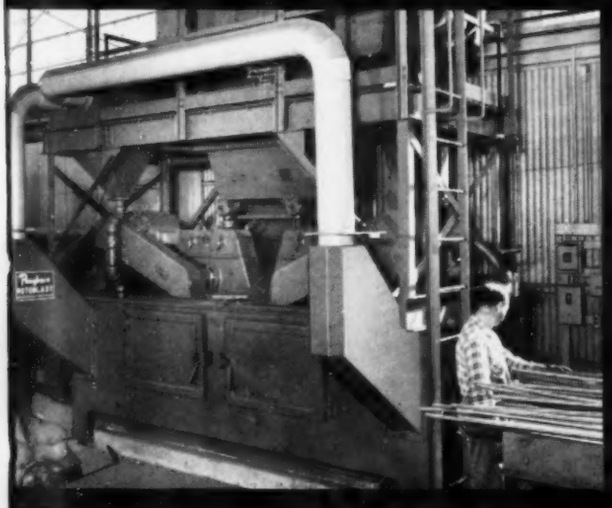
If you have







an unusual blast cleaning problem,



If you are a company with a special cleaning problem, Pangborn offers you a special service—a machine designed for your individual needs. It might be a descaling machine for bars, sheets and coils, a continuous-flow barrel or a monorail cabinet like the machines shown here . . . or it might be completely different. You may need to clean cylinder blocks, bathtubs or any unusual ferrous or nonferrous castings, forgings, stampings. If so, Pangborn engineers will study your problem and its relation to your production line. Then they'll design a Pangborn machine that gives you better cleaning and faster production at lower cost. Pangborn has proved it in hundreds of cases. Pangborn can prove it to you! Write today for Bulletin 1210 to: PANGBORN CORP., 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment.*

*U. S. Pat. #2184926 (other patents pending)

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Pangborn

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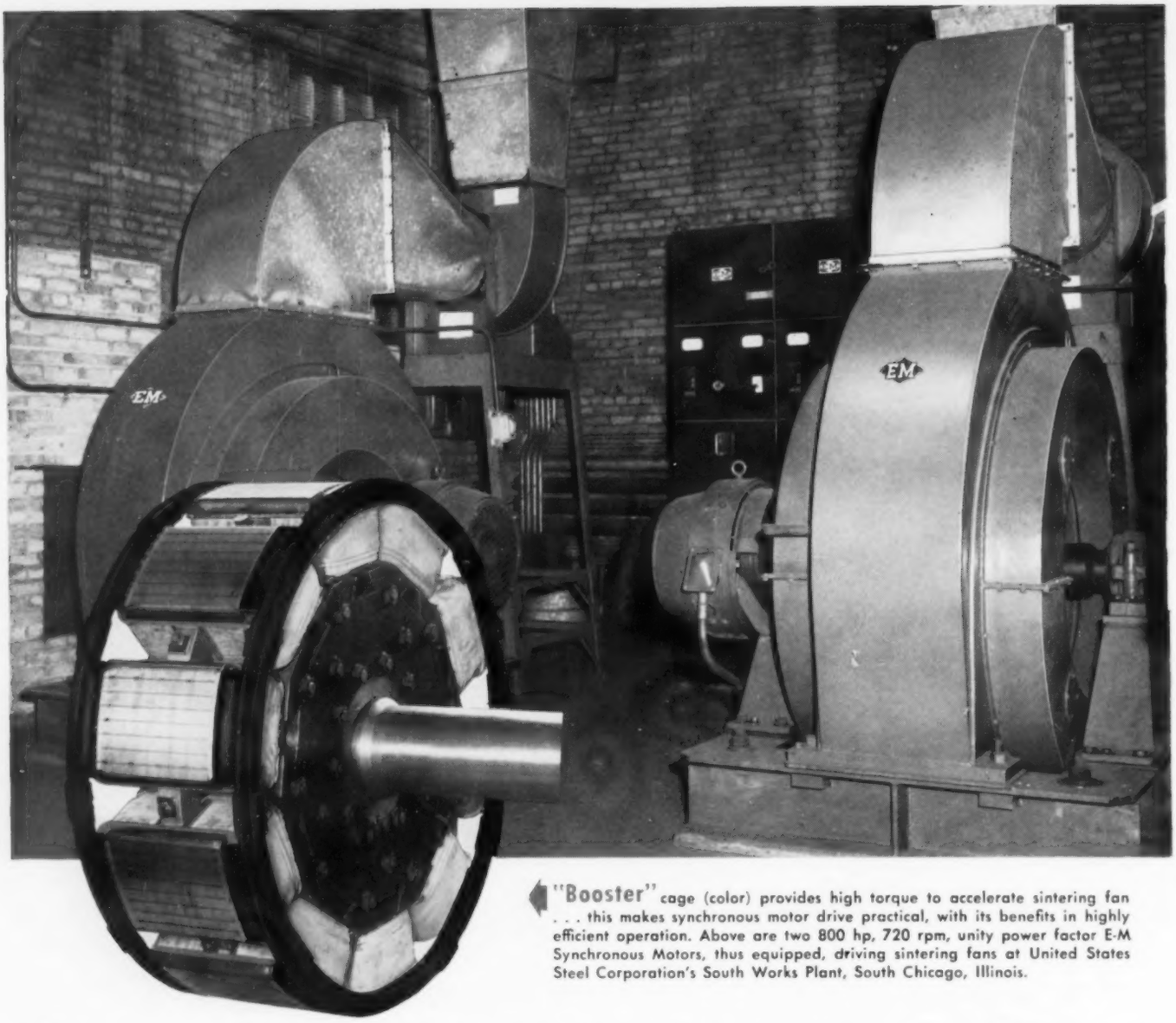
Special Blast Rooms & Cabinets

Pangborn Dust Control Equipment

Distributors for Malleabrasive and Tru-Steel Abrasives.



"Booster" cage (color) provides high torque to accelerate sintering fan . . . this makes synchronous motor drive practical, with its benefits in highly efficient operation. Above are two 800 hp, 720 rpm, unity power factor E-M Synchronous Motors, thus equipped, driving sintering fans at United States Steel Corporation's South Works Plant, South Chicago, Illinois.

How to drive a sintering fan most profitably

● There are sound reasons why synchronous motors (such as the installation above) are the most economical sintering fan drives. Consider your power bill . . . the high efficiency of the synchronous motor produces maximum usable horsepower from a minimum of electric power. Your entire electrical system will benefit from power factor improvement through the unique ability of synchronous motors to correct lagging power factor. You save on power costs both ways. And motor maintenance costs are low too.

However, the fans have a large WK^2, and sintering begins with a cold bed. So, E-M engineers developed a special double-deck starting cage for these difficult starting and synchronizing requirements. Here's what it does:

Characteristics of this E-M extra-heavy-duty double-cage winding are such that uniformly high torque is provided for both starting and pull-in. This E-M winding not only accelerates the heavy fan, but also provides that powerful "boost" to 98½ % of synchronous speed needed to pull it into step.

Further assurance of powerful synchronizing is offered by the E-M-invented Polarized Field Frequency Control which automatically applies field excitation at the instant when rotor angle will give maximum synchronizing power with no pole slippage. Current inrush is held at a minimum.

E-M's pioneering and long experience in synchronous motor applications have resulted in many profitable steel plant installations. Ask your nearest E-M sales engineer for his practical suggestions on your requirements.

ELECTRIC MACHINERY MFG. COMPANY
Minneapolis 13, Minnesota

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E-M

Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

Division of Republic Steel Corp. He succeeds **George R. Schuler** who has been named product engineer for the division, with headquarters in Cleveland. Mr. Van Syke has been with Republic and predecessor companies for the past 32 years. He joined Republic Iron and Steel Co. in 1925 and two years later transferred to what is now Republic's Truscon Division. In 1936 he was promoted to industrial engineer at the Truscon plant. He was named industrial engineer for the Elyria plant in 1944 and held that position at the time of his current appointment.

M. C. Breunsbach has been appointed an assistant superintendent of the Mechanical Department of Bethlehem Steel Co.'s Lackawanna, N. Y., plant. He began work in the Mechanical Department in 1942, and has been supervisor of outside shops since 1952.

Stephen W. Benedict has been elected to the newly created position of executive vice president of The Master Builders Co., division of American-Marietta Co. Mr. Benedict joined Master Builders in 1948 as director of research and has been vice president of research and engineering since 1955. Promoted to other new positions are **Herbert K. Cook,** vice president for engineering, and **Thomas M. Kelly,** vice president for research.

J. C. McCurley has been elected senior vice president of Patterson-Emerson-Comstock, Inc. Mr. McCurley has been with P-E-C since its organization in 1956, joining the company as chief design engineer, and later elected vice president in charge of engineering. He was formerly associated with Republic Steel Corp. for 21 years. **A. W. Brullman** has been elected vice president—engineering. Mr. Brullman joined P-E-C in 1956 following a 15-year tenure with Rust Engineering Co. **Kenneth W. Harris** has been elected vice president. He has served as chief project engineer for P-E-C since formation of the company. Mr. Harris was formerly chief electrical engineer, Warren District, Republic Steel Corp. **William G. Cronk** has been elected vice president of Patterson-Emerson-Comstock, International, Inc. Mr. Cronk has been associated with P-E-C in Pittsburgh for more than 5 years and has served in various capacities in the supervision of engineering and project work. Before joining P-E-C he was associated with Acindar, S. A., a leading steel corporation in Argentina. He was also formerly employed by General Electric Co., supervising installation and construction.

Bartlett Richards was appointed vice president and presidential assistant of Acme Steel Co. At the same time, **Harry R. Sanow** was named vice president of Riverdale operations and **Joseph H. Myers** as general superintendent of the Riverdale Plant. Mr. Richards joined Acme Steel in 1933 as a sales correspondent. He worked successively as a sales engineer and assistant to the works manager. In 1953, he was elected to the position of vice president of production. He became a member of the board of directors during the same year. Mr. Sanow joined Acme in 1922. In 1950 he was appointed director of manufacturing, and general superintendent in 1952. Mr. Myers joined the company in 1946 as a production engineer. He became Engineering Projects Coordinator in 1947 and was appointed assistant superintendent of the manufacturing and Processing Division in 1949. After serving as superintendent of the same division from 1950 to 1954, he was appointed assistant general superintendent, the position he held at the time of his present appointment.

H. J. Leaver has been named vice president in charge of production of Treadwell Engineering Co. Mr. Leaver was associated with the American Steel and Wire Co. from 1933 to 1949 in the capacity of division master mechanic and later as general master mechanic. In 1952 he came to the Treadwell Engineering Co. as assistant to the president after having been employed by the Jones and Laughlin Steel Co. as staff engineer-rolling mills since 1949. Mr. Leaver was appointed works manager in 1953, and has held this position since that time.

Harry Schwartz has recently joined the staff of S. P. Kinney Engineers, Inc., in an engineering and sales capacity. Mr. Schwartz has over thirty-five years experience in the coal and copper mining industries; blast furnace and coke works departments at the Briar Hill Works of Youngstown Sheet and Tube Co., fuel and combustion department of Armco Steel Corp. at

J. C. McCURLEY

A. W. BRULLMAN

K. W. HARRIS

W. G. CRONK

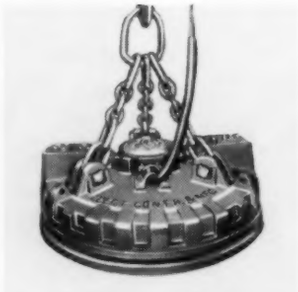
EC&M Lightweight 55" MAGNET

- HANDLES LIGHT SCRAP AT LOWER COST
- WEIGHS UP TO 25% LESS WITH COMPARABLE LIFTING CAPACITY
- FASTER OPERATION OVER WIDER WORKING RADIUS

This magnet, developed by EC&M engineers, is the lightest weight 55-inch magnet. High strength and water-tight construction are maintained with a completely ALL-WELDED design. Elimination of bolt-head recesses allows a better proportion for coil space, giving high lifting capacity. Welding also keeps pole shoes tight.

The companion EC&M lightweight 45-inch magnet has already become popular because its faster maneuverability and greater working radius permit more trips per day. The larger 55-inch magnet incorporates the same profitable advantages. Get the facts...see how these lightweight magnets can cut *your* light scrap handling costs.

Write for Bulletin 900-L



The companion EC&M 45"Lightweight Magnet, now in wide use on boom-cranes

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

7460

Middletown, Ohio; European technical manager for the Armco International Corp; consultant and works manager for various iron and steel interests in Great Britain; and consultant in iron and steel matters for the Solvay Process Division of the Allied Chemical and Dye Corp.

Clem W. Gottschalk has been elected a vice president of Jones & Laughlin Steel Corp. Mr. Gottschalk joined J&L in May, 1911, as a rate clerk in the Traffic Department. He rose through the offices of chief clerk, assistant traffic manager, and general traffic manager, to become an assistant vice president of the corporation in 1951.

Richard E. Corcoran was named to the newly created position of product sales manager of wire and weld products for the Parts Division of Sylvania Electric Products Inc. Mr. Corcoran joined Sylvania in 1951. He was previously with the Battelle Memorial Institute.

R. C. Robinson has been appointed manager of operations for U. S. Steel's American Bridge Division. Mr. Robinson began with American Bridge at its Minneapolis Plant in 1925 as a clerk in the engineering department. In 1938 he was transferred to the Elmira, N. Y., plant as assistant to manager and three years later was named plant manager. In 1954 he was transferred to the Gary, Ind., plant as plant manager, the position he held until his latest appointment.

William Hagel, formerly vice president and executive assistant, has been appointed vice president in charge of operations, United Engineering and Foundry Co. Mr. Hagel joined the company in 1917 and has successively held the position of estimator, chief estimator, assistant to sales manager, assistant sales manager, manager machinery sales, and manager of sales. In 1946 he was elected vice president in charge of sales and in 1953 he was appointed a director of the company.

Donald C. Coleman has been named to the newly created post of director of operations and development, Wilputte Coke Oven Division, Allied Chemical & Dye Corp. Prior to his appointment at Wilputte, Mr. Coleman was superintendent of coke plant at U. S. Steel's Fairless Works, assistant superintendent of Republic Steel's Cleveland coke works and served in a similar capacity at the Brazilian National Steel Co., Volta Redondo, Brazil.

John R. Patton was named assistant manager—roll sales, General Steel Castings Corp. He will make his headquarters at the company's National Roll & Foundry Division, Avonmore, Pa. Mr. Patton joined General Steel Castings' Metallurgical department in 1942 and progressed to chief chemist and later to metallurgist at the company's plant in Granite City, Ill. He joined General Steel's sales organization in June, 1956.

Reginald L. Johnson has been elected vice president of Johns-Manville Sales Corp. In his new post he will head up all Johns-Manville advertising and sales promotion activities. He succeeds **H. M. Shackelford** who has retired after nearly 30 years service.

H. T. Ross has been named vice-president—engineering, Linde Air Products Co., Division of Union Carbide and Carbon Corp. Mr. Ross joined Linde in 1928 as a junior engineer at the Buffalo, N. Y., laboratory. He became manager of engineering for the company in 1955, which position he held at the time of his present appointment.

Norbert C. Hodgson has been placed in charge of sales of Johnston corrugated cinder pots by Mackintosh-Hemphill Division of E. W. Bliss Co. Mr. Hodgson was with the engineering department of Edgar E. Brosius Co. before joining Mackintosh-Hemphill's engineering staff in 1947. In 1952, Mackintosh-Hemphill placed him in charge of engineering of slag handling equipment, including cinder pots. Since then, he has been responsible for all design work on Johnston cinder pots.

P. J. Hughes was recently appointed assistant to the works manager of the Midvale-Heppenstall Co. Mr. Hughes had been with The Midvale Co. for six years and left in 1941. Later he was associated with consulting engineers in the layout and construction

R. C. ROBINSON

WILLIAM HAGEL

D. C. COLEMAN

J. R. PATTON

of steel plants manufacturing forgings for commercial and ordnance products. In 1950 he reactivated the Pencoyd Plant of Carnegie-Illinois Steel Co. and served as executive head. In December of 1956 Mr. Hughes joined Midvale-Heppenstall.

Robert M. Haldeman, general manager of Braden Copper Co., a subsidiary of Kennecott Copper Corp. has been appointed vice president. Mr. Haldeman joined Braden in 1941. In 1951, he was appointed assistant to the general manager and the following year was named general superintendent. He advanced to general manager in 1954.

Howard G. Hart was appointed St. Louis district sales manager of Harbison-Walker Refractories Co. He had been manager of the Specialties Sales Department, with headquarters in Pittsburgh, Pa. Mr. Hart joined Harbison-Walker as foreman in the Portsmouth, Ohio, Works in 1929. He became superintendent of that works in 1934 and later was named superintendent of the Portsmouth district. He has been in the company's sales department since 1947.

David M. Flynn was appointed to the Basic, Inc., sales and service staff. Prior to joining Basic, he was associated with the open hearth department of U. S. Steel's Gary Works.

Charles W. Lockhart was named sales manager of the Blower and Air Conditioning Division of Buffalo Forge Co.

C. W. LOCKHART

Richard K. Teske has been appointed sales representative for Leschen Wire Rope Division, H. K. Porter Company, Inc. His territory will cover the state of Michigan and northern Indiana.

E. F. Helminiak has joined Electro Metallurgical Co., Division of Union Carbide and Carbon Corp., as a sales engineer. Mr. Helminiak is assigned to the Chicago district office. Prior to joining Electromet, he was employed by the Oliver Corp. for six years as an assistant foundry superintendent.

L. C. Hewitt has been elected vice president—research and development, of The Ironton Fire Brick Co. Mr. Hewitt joined Ironton Fire Brick in May, 1955, as director of research.

George E. Hawkins, vice president of Air Reduction Co., Inc., was elected executive vice president of the

G. E. HAWKINS

company by the board of directors. Mr. Hawkins joined the company in 1917, has been vice president since 1941, and a director since 1949.

James H. (Jock) Sutherland was appointed to the position of director of sales and **Edward H. (Ted) Wagner** to Midwestern regional sales manager of SKF Industries, Inc.

J. H. SUTHERLAND

H. H. Brandt has been appointed New York district sales representative for Laclede-Christy Division, H. K. Porter Co., Inc. Previously he was employed by National Carbon Co., and Bethlehem Steel Corp.

Obituaries

Charles A. McCormack, general material supervisor at Allis-Chalmers Manufacturing Co. from 1918 until his retirement December 31, 1950, died January 20. He was 77.

Elmer Elliott, director of engineering, Alliance Machine Co., Alliance, Ohio, was killed in an auto-

Replacement costs take a plunge...when you use pickling baskets of corrosion-resistant Ampco* Metal

AMPCO Metal's high resistance to most corrosive pickling solutions means money saved for you. It means that pickling baskets stay on the job longer, when made of Ampco Metal. It means less time spent for maintenance, repairs, replacement. And Ampco Metal's toughness, coupled with its ability to withstand corrosion, means that you get long, low-cost performance all through your pickling line — from strip rollers, crates, chains, and yokes.

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MILWAUKEE 46, WISCONSIN

West Coast Plant • Burbank, California

mobile accident while returning from a vacation in Florida late in January.

Martin L. Ritter, manager of sales for the Farrell-Cheek Steel Co., died February 8. Mr. Ritter had worked with the firm in a sales capacity for over 40 years.

L. R. Milburn died February 11. Mr. Milburn was born in Patoka, Ind., and was graduated from the University of Michigan with a bachelor of science degree in electrical engineering. After experience with General Electric Co., Mr. Milburn moved to the Louisville Gas and Electric Co., and in 1929 went to Great Lakes Steel Corp., as an electrical draftsman. In 1933 he was appointed acting electrical engineer, and in 1935 he was promoted to electrical engineer. In 1948 he entered the consulting field. Mr. Milburn served as president of the AISE in 1947.

LOYAL R. MILBURN

Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio

IT'S TAPER-LOCK! **IT'S ALL STEEL!**

FULL-DEPTH WELD GIVES 100% STRENGTH

Modern! Superior! Taper-Lock Steel Conveyor Pulleys have terrific impact capability. All welds are made by the submerged arc process for 100% strength. Taper-Lock's back-up bar (pat. applied for) permits a weld of full rim thickness. Diameters 6 inches to 8 feet, all face widths. Popular sizes stocked by Dodge Distributors. Write us for data.

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DODGE

of Mishawaka, Ind.

for hard-tough-dense • concrete repairs . . .

Non-Shrink EMBECO PRE-MIXED MORTAR

Outlasts and outwears plain cement-sand patches because . . .

- *Does not shrink* upon hardening.
- Bonds tightly to old concrete and mortar.
- Tough iron particles serve as reinforcement.
- Density resists water and oil penetration.
- Higher compressive and impact-resistant strength.
- Hard — contains no asphalt.

EMBECO PRE-MIXED MORTAR IS READY TO USE —you add only water.

Used to patch cracks, disintegrated and worn concrete floors, walks, steps, walls, etc.

Write for 4 page folder illustrating many applications.

DIVISION OF AMERICAN-MARIETTA COMPANY

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A two-word history of the overhead-crane industry!

. . . and now a NEW concept– P&H electronic "stepless" control

In overhead cranes, P&H has steadily pioneered new crane design. Now, P&H again moves years ahead of the industry with the modern concept — electronic, "stepless" control . . . excellent control response coupled with extreme simplicity. There are 60% fewer wearing parts in this new overhead crane control.

From P&H you get the most modern crane built—and one that stays modern, as this new control can be applied to existing AC-crane installations.

Write for detailed information and data on this money-saving development, "Electronic Crane Control." Address Dept. 100G, Industrial Division, Harnischfeger Corp., Milwaukee 46, Wis.

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Here's real teamwork! First, the Adams Aftercooler brings the compressed air temperature down — within 10 of the cooling water — where it holds almost 40% less moisture than air from conventional units.

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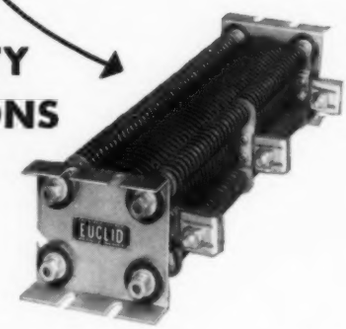
THE EUCLID ELECTRIC AND MFG. CO., MADISON, O.

EUCLID K·1 RESISTORS

FOR HEAVY-DUTY APPLICATIONS

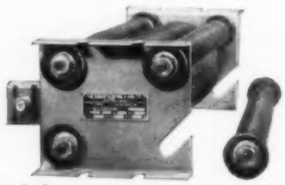


All Steel and Mica Construction provides a truly non-breakable resistor.

Continuous stainless steel edge-wound coil without joints eliminates hot spots, buckling and distortion.

Support rods on outside of coil permit unobstructed cooling air flow and compact design for smaller size and less weight per horsepower.

★ *Exclusive slotted design*



Slotted end frames permit removal and replacement of coil without disturbing rod assembly.

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THE EUCLID ELECTRIC & MFG. CO.
MADISON, OHIO

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PICTURE OF A MAN INSURING HIS LIFE

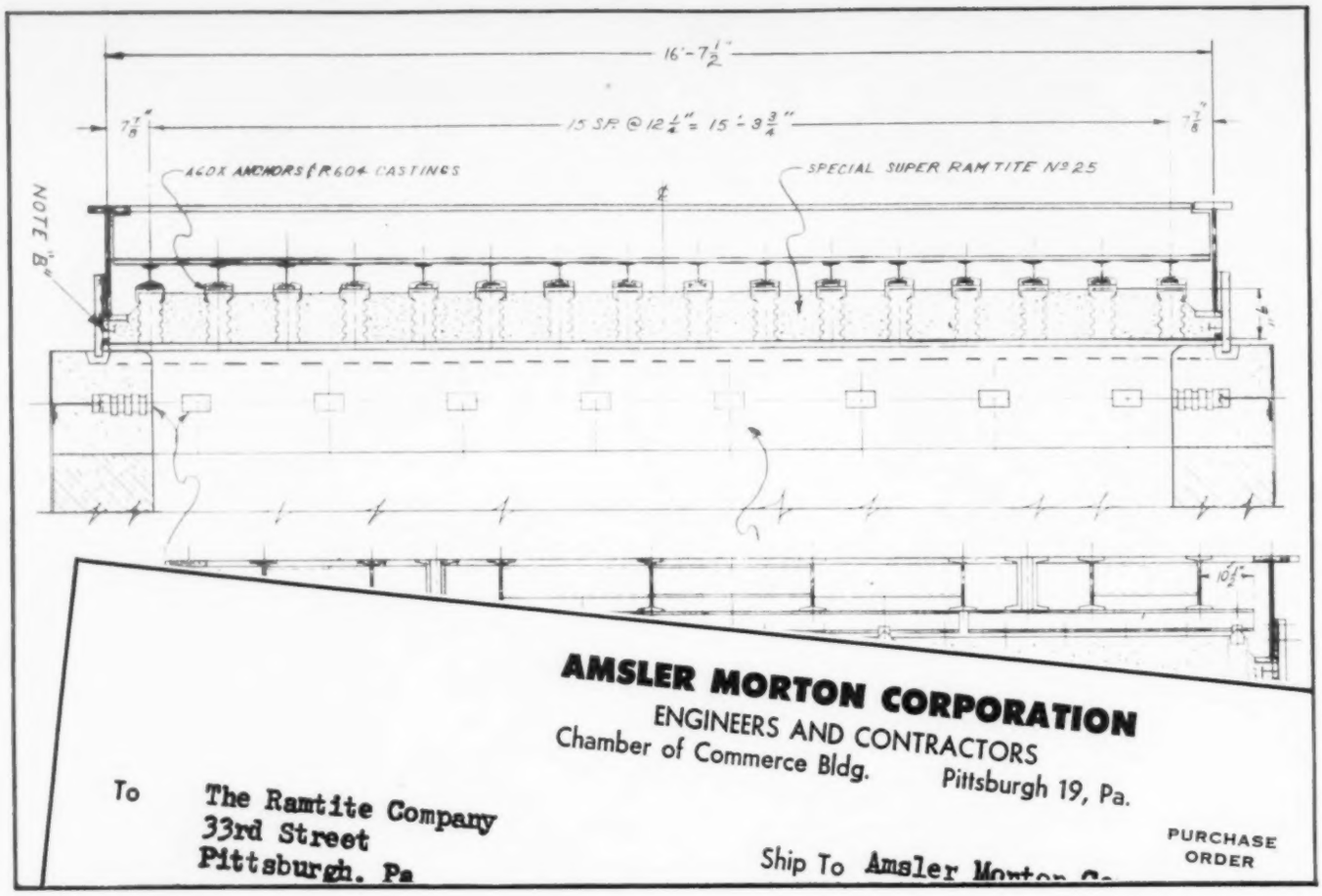
Yes, this man... like hundreds of thousands of Americans ...is taking out a different kind of life insurance. He has an intelligent concern about cancer and knows that early detection may mean the difference between life and death.

That's why, once every year, he goes to his doctor for a thorough medical checkup. This way, cancer... the "silent enemy"... can be detected in its earliest stages, when chances for cure are most favorable.

Last year, 245,000 people lost their lives to cancer... many of them needlessly, because they went to their doctors too late.

That's why we urge all men to make an annual checkup, including a chest x-ray, a habit for life... your life.

AMERICAN CANCER SOCIETY



Again, Past Performance Paves the Way to NEW FURNACE Orders for Ramtite®

In soaking pit covers and copings, as in other refractory applications, it's performance that counts.

This is the reason for the ever-increasing use of Ramtite and for the above purchase order for Ramtite to line new Amsler-Morton soaking pit covers and copings at a southern steel mill.

Ramtite has an appreciably lower K value than fired shapes. Being monolithic it is air-tight, gas-tight and flame-tight. Furnaces heat more steel in less time with less fuel. Also, Ramtite's resistance to the mechanical injury and thermal shock of severe mill operation has often doubled pit cover and coping life. This explains why *there are more soaking pits covers lined with Ramtite than with all other plastic and castable refractories combined.*

The Ramtite Co. offers you a complete sales-engineering service—experienced men who are always available to study your refractory problems and consult with your engineering, mason and ceramic departments about your specific needs.

For additional information, call your local Ramtite representative or mail the coupon below.

CAN YOU AFFORD NOT TO USE RAMTITE?

The Ramtite Co.
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THE RAMTITE CO., Div. of The S. Obermayer Co.
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Please send items checked

- ☐ Bulletin on Casting and Gunning Refractories
- ☐ Steel Plant Bulletin

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© 1957 This is another in a series of advertisements depicting ways Ramtite Refractories serve the steel industry.

Publication Service...

MARCH, 1957

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Slitting Lines Manual

Yoder Co., has published a fully illustrated reference and handbook entitled "Multiple Rotary Slitting Lines." The book provides detailed information on all types and sizes of their slitters and allied equipment. Part I features basic information on design, selection and operation of slitters and slitting lines, including time studies and analysis of operating cycles, discussion of coil handling, scrap disposal methods and other operating data. Part II deals with specifications, capacity tables and other data on Yoder slitters, uncoilers, recoilers, coil cars and scrap choppers.

(2) Refractories Handbook

A new refractories handbook written especially for electric steelmaking furnace operators has been published by Kaiser Aluminum & Chemical Sales, Inc. Many of the suggestions and recommendations in this 48-page booklet have come from joint studies of basic brick and ramming mixes in electric steel furnaces. A few suggestions included in this handbook are method of installing basic brick, methods of installing ramming mix, ramming small furnaces, ramming large furnaces, forms for ramming, furnace lining repairs, tap hole construction and rebuild suggestions.

(3) Steel Data Book

A pocket size data handbook that gives helpful information on machining and fabricating, specifications and tolerances, weights and dimensions, elements and safe loads is available from Joseph T. Ryerson & Son, Inc. Tables, definitions, and general data are also included.

(4) Lubrication Service

A 24-page booklet covering Gulf Oil Corp.'s new service, Petroengineering has been published by the company. The booklet outlines the program—a comprehensive integrated service through which the engineering and research facilities of Gulf are applied for individual uses of petroleum products.

(5) Rust Preventive Manual

A protective coating manual highlighting the stopping and preventing of rust on nearly all types of rustable metal is now available from the Rust-Oleum Corp. This comprehensive manual provides a practical, workable guide for all buyers and users of protective coatings. It contains information and recommendations which enable the user to determine quickly and accurately the specific coatings needed to protect practically any rustable metal surface. (Form No. 256)

(6) Coil Cars

Herr Equipment Corp., has published a bulletin describing their coil cars. The bulletin lists the dimensions of these coil cars in three standard sizes, and includes a calculator for determining the weight, length, etc., of steel and other ferrous and non-ferrous coils when the diameter and width are known. (Bulletin 562)

(7) Roll Neck Bearings

Released by SKF Industries, Inc., is a 24-page illustrated catalog containing complete engineering and technical data on multirow cylindrical roll neck bearings. The catalog illustrates these bearings in 2-high mills, in 4-high mills and in rod and bar mills. Also included are pictures of typical installations of these bearings, their lubrication ease of assembly, mounting and dismounting, engineering data, etc. (Catalog No. 436)

(8) Alloy Chain Chart

Available from the S. G. Taylor Chain Co., Inc., is a wall chart to be used as a guide in the proper use of alloy chains and alloy slings. The 22 x 28 in. chart features a table giving the working load of single, double, triple and quad branch slings—sizes ¼ to 2 in.—when used at 90 degree, 60 degree, 45 degree, 30 degree and 10 degree angles with the load. In addition, the chart provides definitions, instructions, and cautions governing the purchase and use of chain as well as data on inspection, wear, and the use of chain under heat conditions.

(9) Zinc Industry Review

"A Review of the Zinc Industry in the United States in 1956," a new booklet, has just been published by the American Zinc Institute, Inc. The review summarizes the production and consumption picture of the zinc industry as of December 31, 1956. Comprehensive tables cover such topics as mine production, imports of slab and ore, slab zinc consumption, zinc uses by grades, production of slab zinc according to grade, and tariff rates. The growth of zinc used for galvanizing and die casting is discussed, with emphasis on the mounting consumption in continuous galvanizing and the use of zinc die castings by the automotive industry. Present trends in plant expansion are noted, and producers' flexibility of operations commented upon.

(10) Cables

Published by Rockbestos Products Corp. is a catalog on varnished-cambric cables. The catalog covers the complete line of varnished-cambric cables in a voltage range of 600 to 5000 volts for single and three conductor cables braided or lead sheathed. Armored cable constructions in both galvanized steel armor and

aluminum armor are shown in three and four conductor. A useful engineering data section is also included and covers such items as conductors and conduits, insulation thicknesses, braids and finishes shielding, lead thicknesses, electrical circuit formulae, etc.

(11) Plastic Firebrick

J. H. France Refractories Co. has available a service sheet on super duty and regular duty plastic firebrick. Included in the new bulletin are technical data tables, workability indexes, dry and firing shrinkage, water content and panel spalling compared to ASTM standards C176-47. Simplified, nine step installation instructions are listed as well as purported advantages as ease of use, reduction of special shapes, reduced inventory, reduced fuel. Brief descriptions are also included on the company's high alumina plastic, silex graphitic ladle plastic, bench mix for pot furnace use and chrome ore plastic.

(12) Transformer Catalog

Publication of a new distribution transformer catalog has been announced by Pennsylvania Transformer Co. The 56-page book contains dimensions, weights, performance data, and list prices for all standard single-phase sizes of the company's "Pole Star" distribution transformer line, from 3 through 500 kva, through 67,000 volts. Photographs and outline drawings are used to illustrate the construction of both conventional and self-protected units. (Catalog No. 1056)

(13) Weld Tube Mill Handbook

The Yoder Co. has available a handbook entitled "Electric Resistance Weld Tube Mills" which describes in detail the use of modern tube mills in the manufacture of pipe and tube. A step-by-step description of the electric-weld process beginning with the roll forming and shaping of tube, through to the finished product, provides the reader with a thorough understanding of tube manufacture. Photographs, drawings and charts illustrate operation, capacities and applications of electric-weld tube mills of various sizes.

(14) Graphite Base Refractories

A high-grade fine clay blended with graphite and a special bonding agent known as "Helspot" is described in a booklet released by Mexico Refractories Co. The booklet illustrates the applications of this product in iron and steel foundries and steel mills.

(15) D-C Magnet Brake

An eight-page bulletin that describes the outstanding features of a new d-c magnet brake has been published by General Electric Co. The bulletin explains the brake's simplified installation and maintenance procedures, and provides a four-color cutaway drawing that pinpoints its operating features. A wide variety of applications, as well as, diagrams and tables showing how this brake meets AISE standards in 8, 10, 13, 16, 19 and 23 in. wheel sizes are also included. (GEA 6214)

(16) Steel Plate Fabricating

McGregor-Michigan Corp., has published a 12-page brochure on their equipment and typical steel plate fabrications. The brochure describes some of their new equipment including a 650 ton press brake and 600 ton horizontal forming press capable of forming heavy beams or solid sections. In addition, illustrations of steel plate fabrications for the primary metal producers—ladles, buckets, hooks, doors, water-cooled roof rings and others, as well as, chemical and petroleum processing equipment are pictured. Typical miscellaneous industrial fabrications shown are engine beds, bases for machines, jigs and fixtures, heavy-wall cylinders, foundry cupola shells, furnace casings, a self-propelled sewer tunnel shield and a heavy boom for a power shovel.

(17) Combustion Safeguards

A bulletin that descibes and illustrates combustion safeguards has been published by Selas Corporation of America. The bulletin describes the operation and construction of their automatic fire checks and safety blowouts. Also included is a description of their auxiliary equipment such as automatic gas shut off valves, low pressure switches, and audible and visible alarms for use on these safeguards. (Bulletin SC1006)

(18) Oil Tight Control Units

Cutler-Hammer, Inc., has released a 26-page indexed booklet featuring their entire oil-tight push-button line. The booklet illustrates and discusses the company's smooth molded plastic buttons in colors, non blinding indicating lights, knob and key selector switches, covers and enclosures and accessories. Diagrams and dimensional data are also included. (E1-178)

(19) Refractory Bulletin

A complete refractory products list is available from The Ironton Fire Brick Co. This bulletin lists brand names, typical applications of products and special services available from the company. The products list includes information on all classes of fire clay brick plus 70 per cent alumina brick. Information on 25 different refractory specialties is also available.

(20) Cable Insulation

Okonite Co., has released a new booklet entitled "How To Insulate A Cable." The booklet explains the four, most-used methods employed by manufacturers for applying insulation to electrical conductors. It describes the advantages and the disadvantages of each. (Bulletin 1106)

(21) Magnet Controllers

A new bulletin on the company's line of heavy duty magnet controllers is announced by The Ohio Electric Mfg. Co. The bulletin describes both the RD-1 and RD-2 magnet controllers for operating 45 to 80 in. lifting magnets. It gives typical applications for the units, schematic wiring diagrams, and over-all dimensions of push button and lever type masters. (Bulletin MC-143)

(22) Industrial Locomotives

"Six Questions to Ask When Buying an Industrial Locomotive" is the title of a publication available from General Electric Co. The booklet is a guide to purchasers, or prospective purchasers, of industrial haulage equipment. Sixteen pages of photographs and charts describe General Electric's complete line of industrial locomotives, and answer questions that a prospective buyer might ask. (GEA 6445)

(23) Components for Screw Conveyors

A new six-page folder has just been published by Link-Belt Co. describing new related ball bearing equipment being added to their

complete screw conveyor component line. Technical data on selection and application of conveyor screws, trough ends and hangers are detailed in this folder. Examples of how drive-end space problems can be solved are also included. (Folder 2489)

(24) Pneumatic Computing Relay

Bailey Meter Co., has published a new brochure describing the features, application, and operating characteristics of their computing relay for pneumatic control systems. The booklet explains proportional, reset and rate control actions, and provides equations of computing actions. (Product Specification P99-3)

(25) Pollution Control

Wheelabrator Corp., has issued a bulletin on preventing atmospheric pollution caused by fume from electric steel melting furnaces. It includes a general discussion of cloth filtration for cleaning electric furnace ventilation air, and nine photographs of actual installations, showing the effect. Photos show furnaces, hooding, duct work and fume collectors. Operating data is also included. (Bulletin 553-D)

(26) Straight Side Presses

A new bulletin covering their new line of single and double crank straight side presses, is now available from Hamilton Division, of Baldwin-Lima-Hamilton Corp. The eight-page bulletin illustrates, describes and gives specifications for straight side crank-type presses. Press features—such as welded frame design, gibbing, air counterbalance, cushions, knockout bars and flywheel brake—are itemized and explained in detail. A cutaway cross-section of the combined disc-type clutch and brake shows construction details whereby the presses generally can be single stroked at 80 to 90 per cent of continuous running speed. Also described is the method whereby the brake is applied by spring pressure whenever air pressure is released—whether intentionally or accidentally. Two pages are devoted to a tabular presentation of standard specifications for double and single crank presses with capacities of 200, 250 and 300 tons. Press lubrication is described and illustrated by a system drawing. (Bulletin 13300)

(27) Horizontal Redraw Presses

Issued by the Power Press Division of Waterbury Farrel Foundry & Machine Co., is a 12-page brochure which describes its complete line of horizontal, multi-station, automatic redraw presses for quantity production of straight and shouldered, deep shells in a wide variety of sizes and shapes. Detailed information covers 13 machines with 5 to 12 stations having blank length maximums ranging up to 9 in.; production rates to 100 shells per minute. The first section gives basic advantages of horizontal multiple station deep drawing and shows with illustrations and specifications examples of many types of deep shells produced without intermediate annealing. Under separate headings are described blank transfer and knockout, feeding, lubrication and cooling, tooling and drive with accompanying photographs and cross sectional line drawings. A section on special attachments using text, drawings and photographs covers cupping attachments permitting coiled strip to be fed directly into the machine; a shell loading device and floating strippers, both highly useful in large reduction drawing and drawing relatively long shells. A two-page specification table covering the complete standard Waterbury Farrel line completes the brochure.

(28) Instrument Data Sheet

Concise information about the electronic Speedomax G potentiometer instruments, which indicate thermocouple temperatures at the flick of a switch on a drum-type scale 25½ in. long, is presented in an illustrated four-page data sheet just published by Leeds & Northrup Co. This sheet completely lists features, specifications and ranges for (1) a standard-case instrument with door-mounted switches, (2) a small-case instrument used with separately mounted switches, and (3) a console instrument for desk-top mounting, for as many as 200 thermocouple points. (Data Sheet ND46-33(23))

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50	ADAMS CO., INC., R. P.	BULLETIN 711	Cyclone separators and aftercoolers
51	AJAX FLEXIBLE COUPLING CO., INC.	BULLETIN NO. 62A	Dihedral couplings
52	ASKANIA REGULATOR CO.	BULLETIN 33.2	Arc furnace control
53	BABCOCK AND WILCOX CO.	BULLETIN R-35	Refractory castables
54	BAILEY CO., WILLIAM M.		Clay guns
55	BLISS CO., E. W.	BULLETIN 40-A	Rolling mills
56	CHEMICAL CONSTRUCTION CORP.		Washers
57	CLARK CONTROLLER CO.		Control centers
58	DE LAVAL STEAM TURBINE CO.	CATALOGS G-WBV & G-WWH	Speed reducers
59	ELECTRIC CONTROLLER & MFG. CO.	BULLETIN 900-L	Lightweight magnets
60	ELLIOTT CO.		Mill motors
61	ESTERLINE-ANGUS CO., INC., THE	BULLETIN 247A	Operation recorders
62	EUCLID ELECTRIC & MFG. CO., THE	BULLETIN 3004	Resistors
63	FARVAL CORP., THE	BULLETIN 26-R	Lubrication
64	GEAR GRINDING MACHINE CO., THE		Constant velocity joints
65	HARNISCHFEGER CORP.		Electronic crane control
66	HAUCK MANUFACTURING CO.	CATALOG 809	Gas burner
67	HERR EQUIPMENT CORP., THE	BULLETIN NO. 561	Processing and handling equipment
68	HUNT AND SON, INC., C. B.		Control valves
69	KOPPERS CO., INC. (FAST'S COUPLING DEPT.)		Couplings
70	JOHNS-MANVILLE CORP.		Clipper oil seals
71	LARCO, INC.	BULLETIN AC 561	Crane Cab and Pulpit air conditioners (aire rectifiers)
72	LECTROMELT FURNACE DIVISION McGRAW-EDISON CO.	CATALOG 9-A	Furnaces and equipment
73	LINK-BELT CO.	DATA BOOK 2416	Belt conveyor idlers
74	LINK-BELT CO.	BOOK 2550	Self-aligning ball and roller bearings
75	LOEWY-HYDROPRESS DIVISION BALDWIN-LIMA-HAMILTON CORP.	BULLETIN L-144	Services from the planning stage to full scale production
76	LUBRIPLATE DIVISION FISKE BROTHERS REFINING CO.		Lubrication
77	MARKAL CO.		Paintstik markers
78	MASTER BUILDERS CO., THE		Applications of pre-mixed mortar
79	NORTH AMERICAN MFG. CO., THE		Dual-fuel burners
80	OHIO ELECTRIC MFG. CO., THE	BULLETIN 112	Magnets
81	PANGBORN CORP.	BULLETIN 1210	Blast cleaning problems
82	PARKER APPLIANCE CO., THE	CATALOGS 4433, 4310, 4320	Tube and hose fittings
83	POST-GLOVER ELECTRIC CO., THE	BULLETIN NO. 510	Steel grid resistors
84	RADIO CORP. OF AMERICA		Industrial closed television
85	SELAS CORP. OF AMERICA		Tube and bar heating installations
86	SUN OIL CO.	BULLETIN 23	Suntac oil
87	TAYLOR CHAIN CO., INC., S. G.	BULLETIN NO. 131	Alloy slings
88	UNITED STATES GRAPHITE CO., THE		Brushes
89	UNITED STATES STEEL CORP. INDUSTRIAL CARS		Custom designed cars
90	WAGNER ELECTRIC CORP.		Motors
91	WATERBURY FARREL FOUNDRY AND MACHINE CO.		Mill machinery
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93	WHEELABRATOR CORP.	BULLETIN 128-D	Steel descaling

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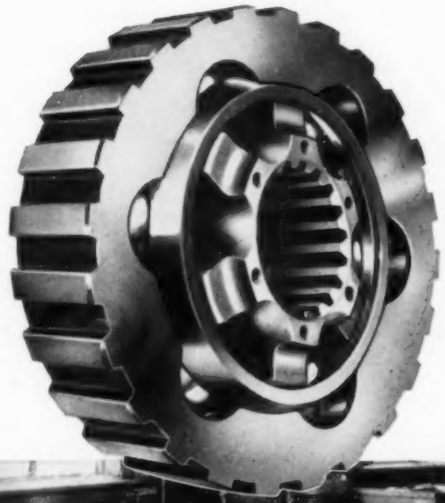
A Constant Velocity Universal Joint may be essential to the top performance of your rolling equipment! Here's Why . . .



Only a universal joint specifically designed to transmit torques smoothly through unbalanced angles, will permit profitable operation of your mill at its maximum rated speed.

The most advanced mills are now being equipped with Rzeppa Constant Velocity Joints.

You can actually *measure* these improvements Rzeppa Joints provide:

- STEPPED-UP ROLLING SPEEDS
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- INCREASED RANGE OF SIZES ROLLED
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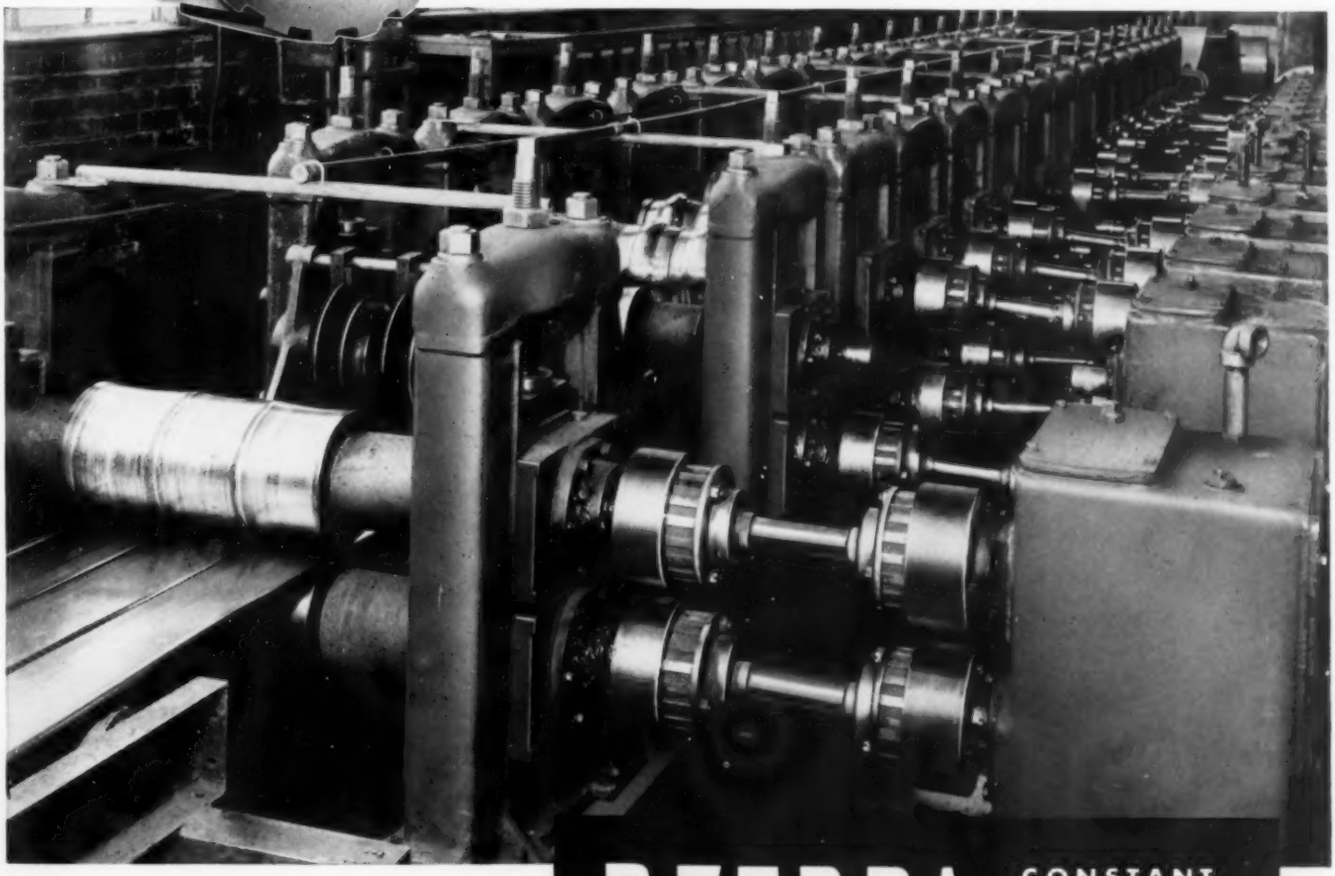

Why not investigate the outstanding features of Rzeppa Constant Velocity Joints. Write today for literature . . . or for a sales engineer to call.

RZEPPA "SHEPPA" CONSTANT VELOCITY UNIVERSAL JOINTS

THE GEAR GRINDING MACHINE COMPANY
3929 Christopher, Detroit 11, Michigan
Manufacturers of:
Fully Automatic Gear Grinding Machines • Detroit Screwmatic 750 single spindle screw machines

for higher performance it's

OHIO MAGNETS

Size for size, Ohio Magnets lift larger loads over longer periods because they *operate cooler*. So for extra magnet lifting power, extra magnet value—always specify Ohio Magnets and Ohio Magnet Controllers. There's a type and size for every lifting job. Send for free copy of Bulletin 112, or consult the Yellow Pages for Ohio offices in principal cities.

AA-1477

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5400 DUNHAM ROAD • MAPLE HEIGHTS • CLEVELAND, OHIO

ohio ELECTRIC

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Ohio Also Makes Separation Magnets • Nail Making Machines • Fractional Horsepower, Shell and Torque Motors

DONALD C. POWER *Portrait By Fabian Bachrach*

General Telephone shows gain of 140% in Payroll Savings Plan

"The qualities of thrift and good management are just as important to the individual worker as they are to the man who operates a business. Setting aside a little of what you earn today for emergencies or future plans is sound policy for everyone.

"That's why I am so enthusiastic about the way our General Telephone System employees have been purchasing U.S. Savings Bonds by the Payroll Savings Plan. In a recent person-to-person canvass which put Payroll Savings Application Blanks in the hands of our employees, enrollment in our Payroll Savings Plan increased from 5,838 to 14,156—a gain of 140%.

"It is fortunate that the world's safest investment benefits both the buyer and the United States Government that serves and protects him."

DONALD C. POWER, ***President***
General Telephone System

Encouraging *your* employees to join *your* Payroll Savings Plan is good business for *you, them* and *your* country. Your State Director will gladly help you install a Payroll Savings Plan or revitalize a present one. Phone or write the Savings Bonds Division, U.S. Treasury Department, Washington 25, D. C.

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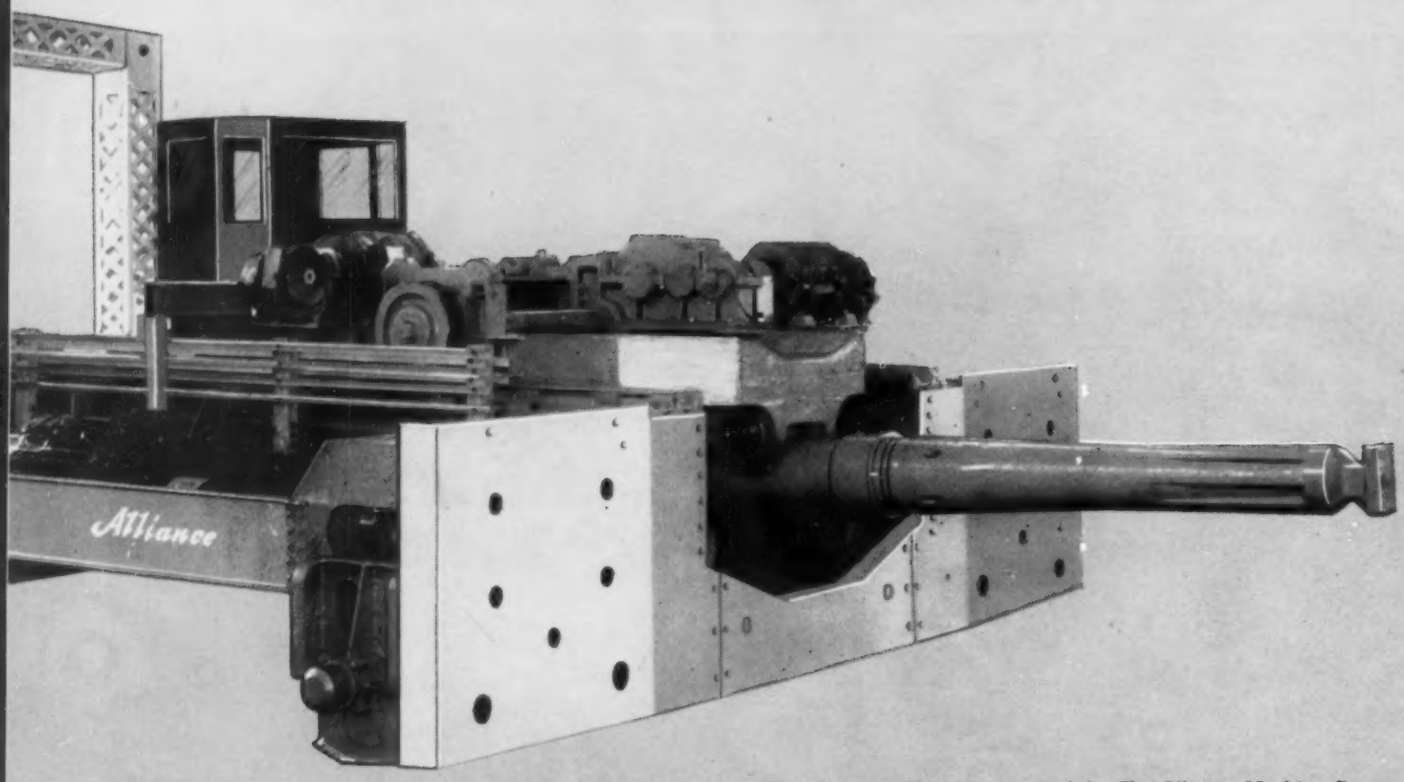

This Charging Machine was built by The Alliance Machine Company, Alliance, Ohio . . . leaders in the heavy material handling equipment field for over 50 years. Contact Alliance for your requirements.

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COKE PUSHERS

•

New 12-TON CHARGING MACHINE

• **The NEW Alliance 12-ton,** low-type open hearth Charging Machine has spring-loaded pitman so, if the charging box pushes up over scrap in the furnace, the trolley's front wheels remain on the rails. Trolley always has sufficient traction to retract peel and box from furnace.

• **Each bridge girder** of Alliance's NEW Charging Machines consists of two wide-flanged I-beams welded to form a box section. Between webs of this box section, diaphragms are welded at 3-ft. intervals. This, plus other welded reinforcements, keeps charging machine square and rigid.

• **Machinery deck plate,** extending full length of bridge between main girder and outrigger girder, laterally reinforces the main girder and helps keep charging machine square and stable under all operating conditions.

• **Stabilized, shock-absorbing wheels** operate at rear end of trolley. Two rear wheels engage upper rail; two adjacent wheels engage lower rail. Powerful springs hold wheels in contact with rails at all times. This spring suspension absorbs and disperses engaging and disengaging shock at end of the peel, reducing operator shock and fatigue to a minimum.

• **On eight-wheel bridges,** the four trucks located at corners of the bridge are equalized to compensate for any track irregularities.

• **New hydraulic lock rod** gives operator finger-tip control and eliminates laborious work incident to the hand-operated lock rod. All gears (including track wheel gears) are fully enclosed and run in oil.

WORLD'S LARGEST BUILDERS OF WORLD'S LARGEST CRANES

Founded 1901

THE *Alliance* MACHINE COMPANY

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GIVE US THE RUNWAY AND WE'LL LIFT THE WORLD

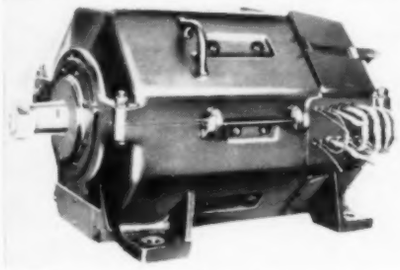
Equipment News...

AISE MILL MOTOR

▲ Westinghouse Electric Corp. has announced a new heavy-duty mill motor, type 620 mc as an extension of its 600 series of silicone-insulated mill motors.

Slightly larger than its predecessors, it retains such features as a cast-steel, split-type frame, integral bearing and housing assemblies, large-diameter shaft between bearing supports, and compact mechanical design.

The new motor is available in ratings of 275 hp (1-hr., 75C,



totally enclosed; or continuous, 75C, open, protected) 360 hp (½-hr., 75C, totally enclosed) and 350 hp (1-hr., 75C, open protected). The new design is built to meet AISE standards as to ratings and dimensions.

Among its first applications are service as a processing motor on a pickling line, as a shear drive for a reversing slabbing mill and as motors for a shovel-hoist, an edger roll drive on a universal roughing mill, and a barney hoist in a sintering plant.

SAFETY SWITCHES

▲ Announced by the Square D Co. is a line of safety switches meeting the new NEMA Standards. This new industry specification clarifies the conflicting features which existed under old designations, specifies added performance and introduces a new heavy duty industrial switch.

Type LD for light duty replaces the former D or G types. Square D's line includes a full range from 30 to 200 amp in both general purpose and raintight enclosures. NEC horsepower ratings are included.

Type ND for normal duty and commercial work replaces the former H, S, A or C designations. The full line extends from 30 through 1200 amp in both 250 and 600 v, ac and dc, in both general purpose or raintight enclosures. Both NEC and Dual Element horsepower ratings are included. Square D's type ND switches include a quick-made, quick-break operating mechanism independent of the handle and silver plated current carrying parts. These switches exceed UL endurance standards.

Type HD for heavy-duty industry use, is a new premium performance switch. Enclosures include the gasketed industrial (NEMA 12) type as well as watertight and dusttight and explosion-resisting types. In addition to the requirements of ND types, it has even greater safety and endurance, heavy electroplated silver on all current parts and interchangeable lugs.

PRESET CONTROL

▲ Installation of what is believed to be the world's first card-programmed preset control in the steel industry has been announced by Allegheny-Ludlum Steel Corp. and the General Electric Co.

The control, installed on a reversing roughing mill at the steel company's Brackenridge Works, was developed by GE's General Engineering Laboratory and manufactured by the company's Industry Control Department. Allegheny-Ludlum uses the new system in the production of electrical steels.

The card-programmed system is capable of controlling 15 programmed passes from a single card at accuracies of approximately $\frac{1}{100}$ in.

The control utilizes an electronic counter, which is preset by punched card data, to regulate the screwdown position. Feedback is measured by pulses from a magnetic pickup-toothed disc transducer and is compared with the preset value. The error in position is converted to a proportional signal which drives the screwdown control. The maximum opening is 9.99 in. with settings provided at intervals of 0.01 in. Maximum screwdown speed is 40 in. per min.

The equipment utilizes 13 vacuum tubes, 25 transistors, and two amplistats in addition to the customary voltage control for the 150-hp mill-type motor.

Closeup view of the entrance end of Allegheny-Ludlum's reversing roughing mill with the operator's control room at right.

You're SAFER

– time and money ahead

with – TM factory made

ALLOY SLINGS!

TAYLOR uses

GAMMA RAY

QUALITY CONTROL

on master, joiner and end links...

CONTROLLED-ATMOSPHERE HEAT-TREATING

on popular chain sizes...

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TAYCO HOOKS!

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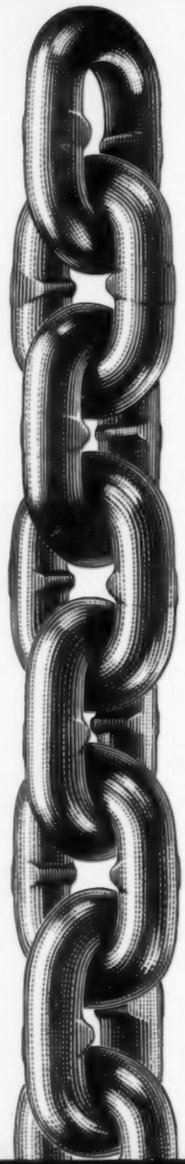

Famous TM factory made Alloy Sling Chains are tougher—safer! The use of Gamma Ray assures flawless, trouble-free welds on master, joiner and end links. This, in addition to our rigid standards... Controlled-Atmosphere Heat-Treating of popular sizes... patented Tayco Hooks and other superior production techniques, makes TM factory made Alloy Slings a better buy!

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TAYLOR MADE A GREAT NAME IN Chain SINCE 1873

S. G. TAYLOR CHAIN CO., INC.
A complete line of quality chain!
Main office and plant—Hammond, Ind.
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3505 Smallman St., Pittsburgh, Pa.

Manual adjustment is not necessary because the system itself controls the setting and speed of the rolls. Once the proper card has been inserted into the card reader, a button is pressed to actuate the mill. Consequently, the rolls are positioned more accurately and variations in performance by different operators are eliminated. The result is a more uniform quality of steel.

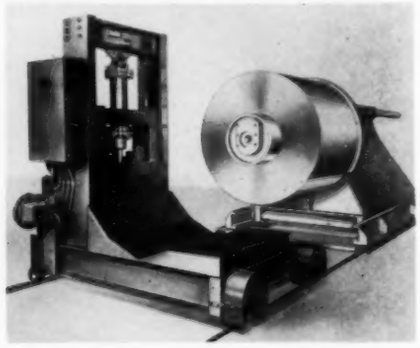
The use of punched cards enables the operator to maintain on file a large number of schedules for a wide variety of products and permits a rapid change from one schedule to the next.

Although the initial application of the control is on a reversing roughing mill, GE engineers say it can also be applied to blooming, slabbing, and cold rolling mills.

COIL CAR

▲ Herr Equipment Corp. has introduced a heavy-duty coil car for loading coils onto pay-off reels and unloading coiling reels.

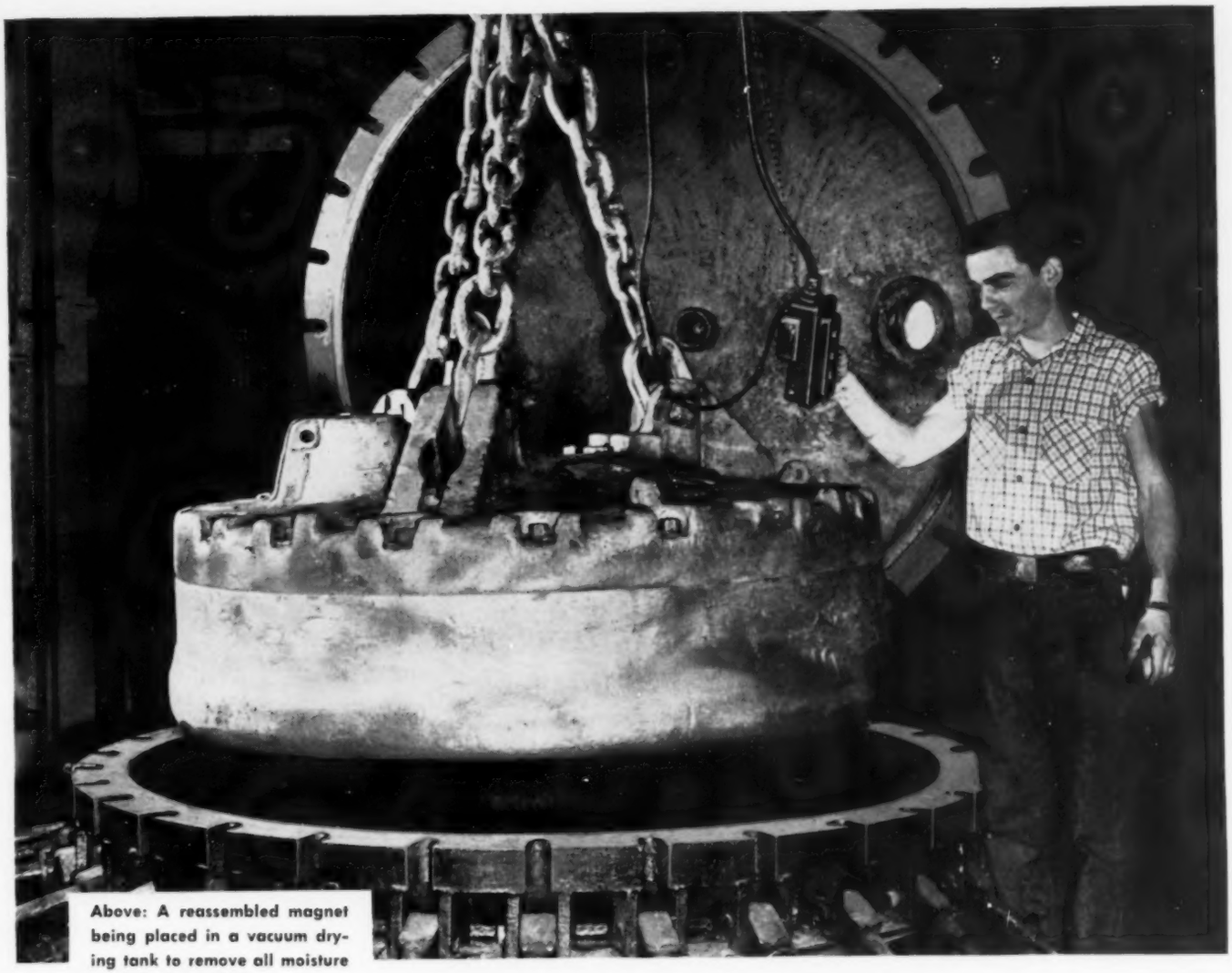
Coils are carried in a heavy steel cradle supported in a rigid L-shaped frame which is raised and lowered hydraulically. The cars are provided with through axles, roller bearings and flanged wheels and



operate on two rails set at floor level, thus eliminating the need for pits.

The car is loaded with a coil from a coil ramp, lift truck or crane, and is then moved across the tracks into position near the reel, to be ready to reload the reel quickly as soon as the preceding coil is free.

Power is supplied from an outlet near the end of one of the rails, and carried to the controls in the car with a cable, which is coiled and uncoiled by a reel in the car as the car moves back and forth. A guide wheel lays the cable in a recess alongside the rail as it is uncoiled, thus protecting the cable from damage, and permitting unrestricted



Above: A reassembled magnet being placed in a vacuum drying tank to remove all moisture before compounding.

Below: Magnet case being opened on a large capacity boring mill. Capsule-type magnet coils must also be opened by cutting on this mill.

NATIONAL

is equipped for high speed, high quality

Lifting Magnet Repairs

National's lifting magnet department has the equipment, manpower and the "know-how" to restore your lifting magnets to original specifications — and to improve them by redesign which takes full advantage of recently developed techniques and materials. And the new, modern equipment in this department not only insures high quality but speeds production.

For details on what these facilities can mean to you, just call your nearby National field engineer or drop us a line.

NATIONAL ELECTRIC COIL COMPANY

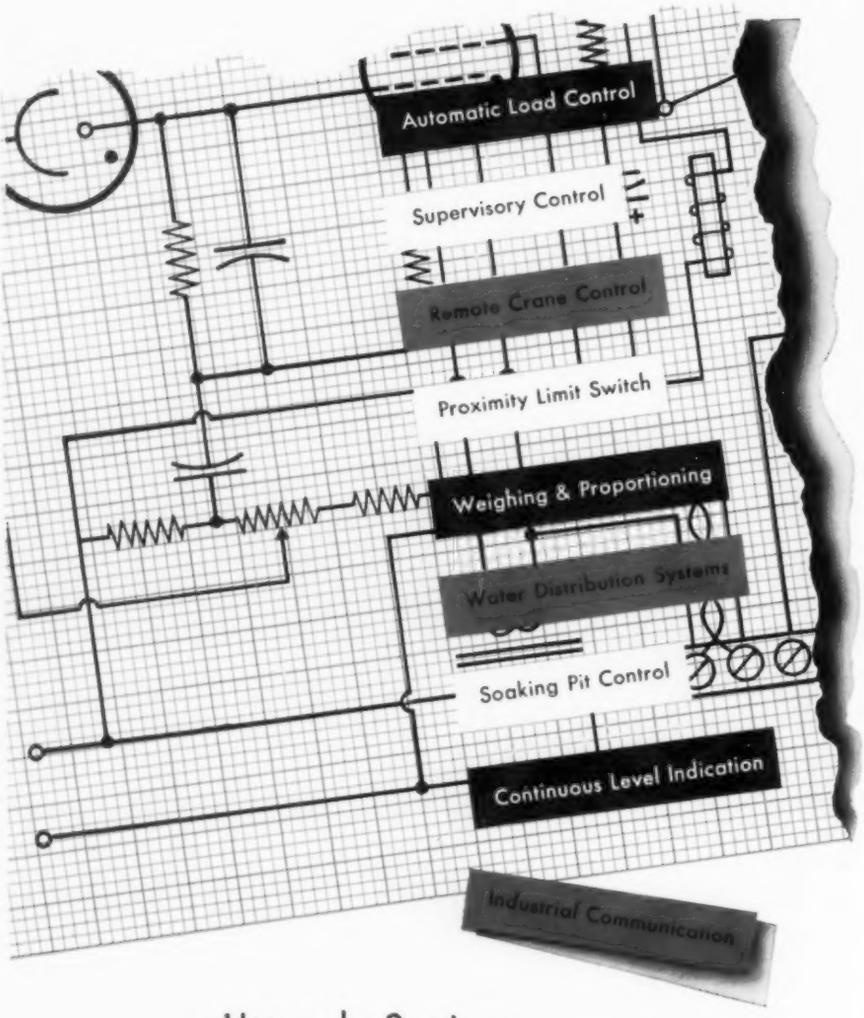
COLUMBUS 16, OHIO, U. S. A.

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION— REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

Femco

CONTROL SYSTEMS

ENGINEERED FROM STANDARD COMPONENTS



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or existing power circuits.
You save time, money and motion.
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movement of lift trucks and other traffic across the tracks.

The hydraulic cylinder that raises and lowers the cradle, and all controls, is mounted in the vertical housing. The coils, consequently, are carried very close to the floor permitting low, sturdy mounting of both the pay-off and coiling reels.

RAM TRUCKS

Elwell-Parker Electric Co. announces a new series of heavy duty ram trucks, with capacities from 20,000 lb to 80,000 lb.

The new trucks are designed to handle sizes and weight loads encountered in steel mills, warehouses and heavy metalworking plants.

The models have dual drive motors to meet heavy power demands, power hydraulic wheel brakes and steering for efficiency and safe handling, narrow truck width for maneuverability and simplified maintenance for low downtime.

A redesigned lift mechanism eliminates all lift chains, so there is no possibility of load dropping due to chain breakage. With the redesigned lift unit, the operator can clearly see the tip of the ram from his compartment.

Use of centersill type frame construction makes it possible to attach sub-assemblies directly to the frame, so each can be removed independently. Propeller shaft construction of the power plants allows removal of motors for servicing without disturbing reduction units.

SPEED REDUCERS

A new line of double and triple reduction speed reducers, with ratings up to 50 horsepower and efficiency ranges from 97 per cent or better, have been announced by Western Gear Corp.

The speed reducers bear the trade name "Strait Line" and are immediately available in all models.

STRETCH-STRAIGHTENER

Sutton Engineering Co. has announced availability of a new 25-ton hydraulic stretching and detwisting machine for finishing extruded aluminum alloys.

Any tube, bar or structural shape which can be enclosed within an 8 in. dia. circle, in lengths from 6 to 100 ft or longer, can be stretch-

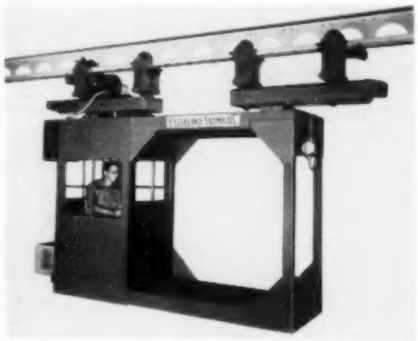
straightened at high production speeds.

Jaws in the headstock and tailstock are vertically positioned for a fast horizontal material pass line. Clear passage is provided for the extrusion through the detwisting head so that localized detwisting may be accomplished.

CARRIER

▲ A new carrier for operation on overhead tramrail systems has been completed by the Cleveland Tramrail Division of the Cleveland Crane & Engineering Co. Although it was designed especially for conveying ladles of hot metal used for die casting, the platform can be changed in size and adapted for other materials handling purposes.

The carrier illustrated has a cab which is enclosed with aluminum



paneling and is provided with air conditioning to keep the operator comfortably cool while transporting molten metal. The door has a safety switch that prevents the carrier from being moved when the door is open.

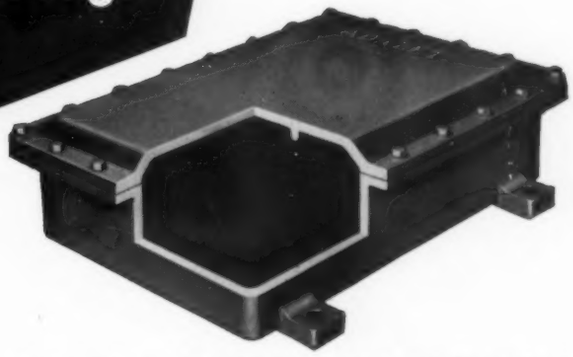
The unit has a capacity of 3100 lb and travels at speeds to 300 fpm.

MAGNETIC PIPE ROLLS

▲ Six permanent magnetic pipe rolls, recently installed on three automatic pipe facing machines at the Benwood, W. Va., works of Wheeling Steel Corp. are credited with reducing the required number of motor-driven cast rolls from 25 to 6, and with elimination of personnel contact with pipe in this operation.

The non-electric magnetic units are special pipe control and conveyor rolls, produced by Eriez Manufacturing Co. They are being used to convey ½-in. to 3-in. pipe between the facing machines at a rate of 2,000 20/21-ft pieces per hour. Because motors subjected to the rough usage common to such

Explosion-proof Housings cast aluminum



Non-sparking cast aluminum, strong and rustless. Available in a wide range of standard and special sizes.

Lightweight, easily mounts onto equipment. Drilled and tapped to specifications. Made to Underwriters and Military Specifications.

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We will send you without cost or obligation a MARKAL PAINTSTIK. They are available in various types suitable for marking on any kind of material. Hot surfaces up to 2100°F, cold down to −50°F; acid or alkali conditions; wet, dry, icy, oily, rough, smooth. For welding or heat treating . . . many others. Markal Paintstiks are Permanent, Fadeproof, Weatherproof.

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Yes—I want to try marking with a MARKAL PAINTSTIK! Here's what I want to mark:_____

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MARKAL COMPANY 3087 West Carroll Avenue • Chicago 12, Illinois

equipment require almost constant maintenance, the elimination of 19 motor-driven cast rolls has brought a significant increase in efficiency, as well as a reduction in power costs, to this procedure. In addition, since the magnetic rolls have been found to eliminate bounce and slippage, manual handling of pipe is no longer required and the potential hazards of this work have ceased to be a factor.

The pipe rolls are easy to install because they are designed to match the dimensions of existing non-magnetic rolls.

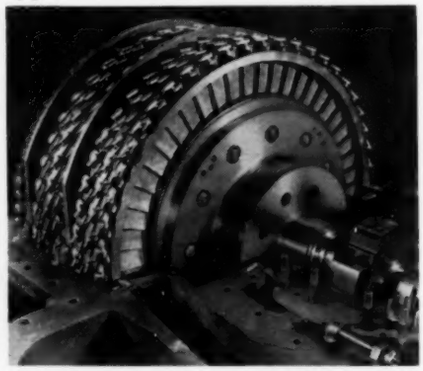
COMPRESSORS

▲ Introduction of new type axial compressors with full stator blade control for extended range of operating conditions with high efficiency has been announced by the Allis-Chalmers Manufacturing Co.

The new model axial compressors can be used with almost the same capacity variation as centrifugal units and still maintain the high efficiency and pressure rises at part load points which are characteristic of the axial compressor.

The machines are particularly adapted for large volume applications where capacity variation is necessary. This is particularly true where large electric motor drives are used and constant speed operation is preferred in order to take advantage of the lower initial cost and more favorable operating characteristics of a synchronous motor.

Each row of stator blades may be positioned through either a hydraulic master positioner or through electric motors and gearing which are used to position the blades. This type of arrangement allows individual rows of stator blades to be adjusted separately or all can be tied together to move at one time. Usually, the latter type of operation is all that is needed unless extremely fine control variation is necessary. Then the individual rows can be adjusted separately for optimum operation.

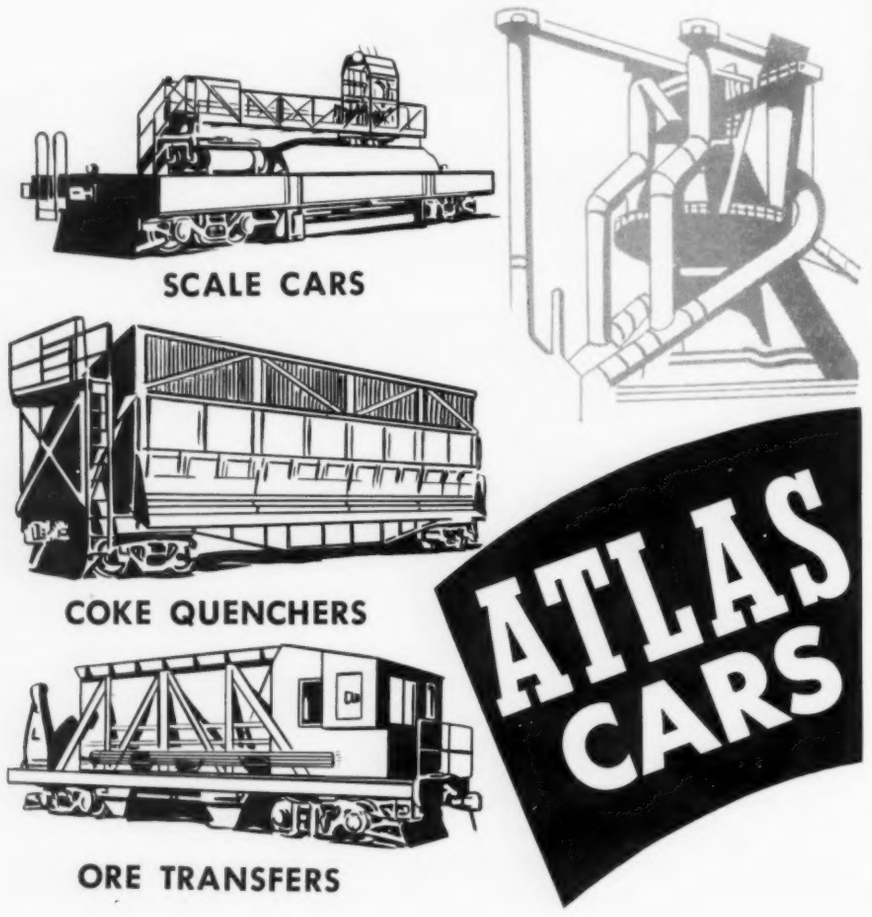


REGULATOR

▲ Developed by Westinghouse Electric Corp. is a new regulator for electrode control of large electric arc furnaces capable of driving the electrodes at speeds and responses up to the limit that the drive motor can stand. The regulator's high performance is a result of a new application of magnetic amplifiers.

Commutating ability of the motor is the ceiling that limits the electrode speed and response that can be furnished by the control. Thus to make sure that the drive motor does not unduly limit the new magnetic amplifier control, low-inertia steel-mill motors, specifically designed to commutate heavy armature currents, are used.

The regulator for each electrode uses a reversing magnetic amplifier to control a motor-generator set. Signals of arc voltage and arc current are compared by the regulator. Magnitude and direction of the output depends on which of the signals is the stronger, and on the ratio of



These cars are built to give the dependable service required for continuous furnace operation. All approved modern safety devices are incorporated for extra factors of safety.

Each car is engineered to meet the operating conditions of the plant where it will be used.

CONSULT ATLAS FOR YOUR STEEL PLANT CARS

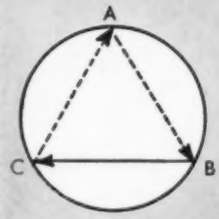
THE ATLAS CAR & MFG. CO.

ENGINEERS MANUFACTURERS

1149 IVANHOE RD. CLEVELAND 10, OHIO, U. S. A.

RELIABLE PHASE FAILURE OR PHASE REVERSAL PROTECTION

TYPE A PHASE FAILURE RELAY



Sensitive to current in all lines to motor. If one current fails or becomes less than current in other lines, relay opens control circuit. Protects motor against phase failure on primary side of transformer supplying motor, even though it has wye-delta windings.

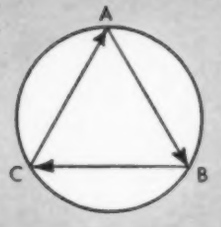
The Bulletin 812 Type A phase failure relay is a static device which compares currents in each of the three lines supplying a 3-phase motor. If current in one line fails or becomes much less than in the other two lines, relay operates to open control circuit to starter which disconnects motor from line and prevents it from running single phase.

Both Bulletin 812 Type A and Type B relays operate over a wide range of current, so coils need not be accurately selected for precise current drawn by motor. They will function accurately for currents from no load to locked rotor.

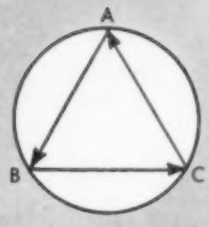
Control circuit contacts are opened in 3 or 4 cycles after phase failure. Thus, relay protects against failure of motor to reverse. If a single phase or a phase failure occurs, Bulletin 812 relays will operate dependably because relays do not include frail or moving parts, especially in sensitive portion of system. There are no delicate parts to get out of adjustment, or bearings which might stick and cause faulty operation.

Bulletin 812 relays are built in only 4 sizes and will protect motors with full load currents from 1.25 amperes to 300 amperes against phase failure and phase reversal. Let us send you detailed information about this up-to-date answer to phase failure and phase reversal problems!

TYPE B PHASE REVERSAL RELAY



In addition to phase failure, this relay detects phase sequence and opens control circuit when phase is reversed.



A-B Quality

The Sign of
QUALITY
MOTOR CONTROL

Allen-Bradley Co.
1343 S. First St.
Milwaukee 4, Wis.

ALLEN-BRADLEY

QUALITY

PHASE FAILURE AND REVERSAL RELAYS

In Canada—
Allen-Bradley
Canada Ltd., Galt, Ont.

...22,461 SALESMEN on the job every day for ILLINOIS GEAR

The more than 22,461 customers of ILLINOIS GEAR . . . *and every one a satisfied customer* . . . are the hardest working salesmen ever.

Gears they use are on the job every day . . . telling the story of outstanding quality and performance that characterizes Illinois Gears.

The great array of fine equipment and machinery of which they are a part is indicative of the wide range of types and sizes of Illinois Gears . . . America's *most complete line of gears.*

Regardless of the service, whether it's gears for rotating massive shovels, or gears that control delicate precision equipment — depend on ILLINOIS GEARS.

Look for this mark ILLG® *the symbol on finer gears*

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Gears for Every Purpose ... one gear or 10,000 or more

ILLINOIS GEAR & MACHINE COMPANY

2108 NORTH NATCHEZ AVENUE • CHICAGO 35, ILLINOIS

the signal strengths. Generally speaking, the voltage provides the "lower" signal, current provides the "raise" signal. A motor-generator set in turn powers the electrode motor, following the directions given by the regulator.

Auxiliary equipment limits the electrode speed, motor armature current, maximum arc current and other factors.

STARTER

▲ A new, high-voltage starter, Type ZHA (2200–4800 v), has been introduced by the Electric Controller & Manufacturing Co., a division of the Square D Co. Completely accessible from the front, these starters may be mounted directly against wall or in double rows, back-to-back. Surprisingly compact, the Type ZHA is only 30 in. deep—an important feature where floor space is a factor.

This new starter is self-contained, complete with control transformer supplying low voltage for pushbutton circuits. When starters are ganged, only one incoming feeder is required. Additional starters can be

added as needed, with no sacrifice in streamlined appearance. The Type ZHA is also available with self-contained bus in an isolated compartment. It is furnished in three interrupting ratings for squirrel cage, synchronous and wound-rotor motors. Class E1—50,000 kva (certified). Class E2—with current limiting fuses and high interrupting capacity contactor. At 2300 volts: 150,000 kva, 3 phase; 60,000 rms amp asymmetrical. At 4800 v: 250,000 kva, 3 phase; 60,000 rms amp asymmetrical. Valimitor—may be used on a bus of unlimited short circuit capacity, through the use of a contactor with an interrupting rating of 50,000 kva, and reactors which limit any fault current to a maximum of 25,000 kva.

THRUST BEARING

▲ Rollway Bearing Co.'s special double-acting aligning thrust bearing is designed for the most severe conditions where potential misalignment and heavy but intermittent thrust loads from either direction are present. In assembly for steel forming passes, the special bearing consists of two center thrust plates, two roller assemblies, a left-hand convex-curved thrust plate with concave-curved aligning plate, a right-hand concave-curved thrust plate with convex-curved aligning plate and an inner spacer sleeve.

One-inch diameter rollers are staggered to insure even wear distribution: three $^1/_2$-in. long rollers in each of 10 slots, and two $^3/_4$-in. long rollers in 10 alternating slots. Bearing thrust capacity, at 100 rpm, is 114,275 lb.

This Type DAT thrust bearing is

(*Please turn to page 227*)

for intense concentration of heat...

The BLOOM HTR BURNER

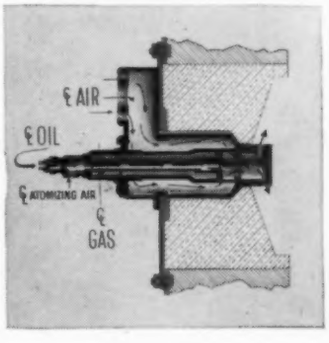
The Bloom HTR Burner provides identical operation on either gas or oil.

This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.

PATENT PENDING



BLOOM ENGINEERING CO., INC.
837 W. North Avenue Pittsburgh 33, Pa.

2,300,000 pounds ship-to-shore in one hour!

Westinghouse-equipped ore unloaders set new highs in speed and dependability for McLouth Steel

Power. Durability. Precision. These were the requirements for the motors and controls to operate these two 547-foot ore bridges for McLouth Steel. Westinghouse supplied the solution with rugged MC mill motors and the newest developments in automatic controls—Magamp* and Rototrol®.

In just 41 seconds, these ore bridges run a complete cycle—digging, hoisting, trolleying, dumping, rehoisting and back again for another 27,000-pound scoop.

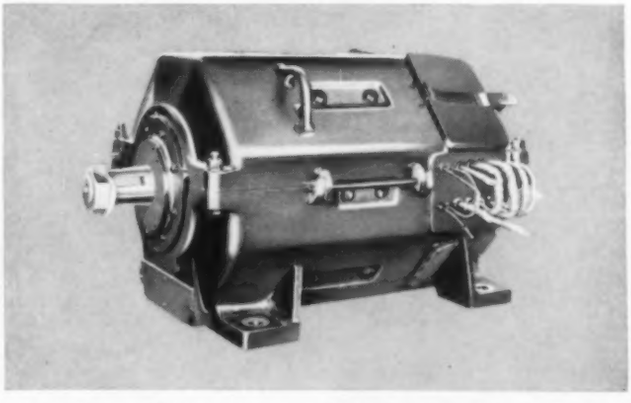
It will pay you to investigate the facts that give such outstanding results as these when you are considering motors, drives and controls. Get the details from your Westinghouse sales engineer. Or write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.

*Trade-Mark
J-21957

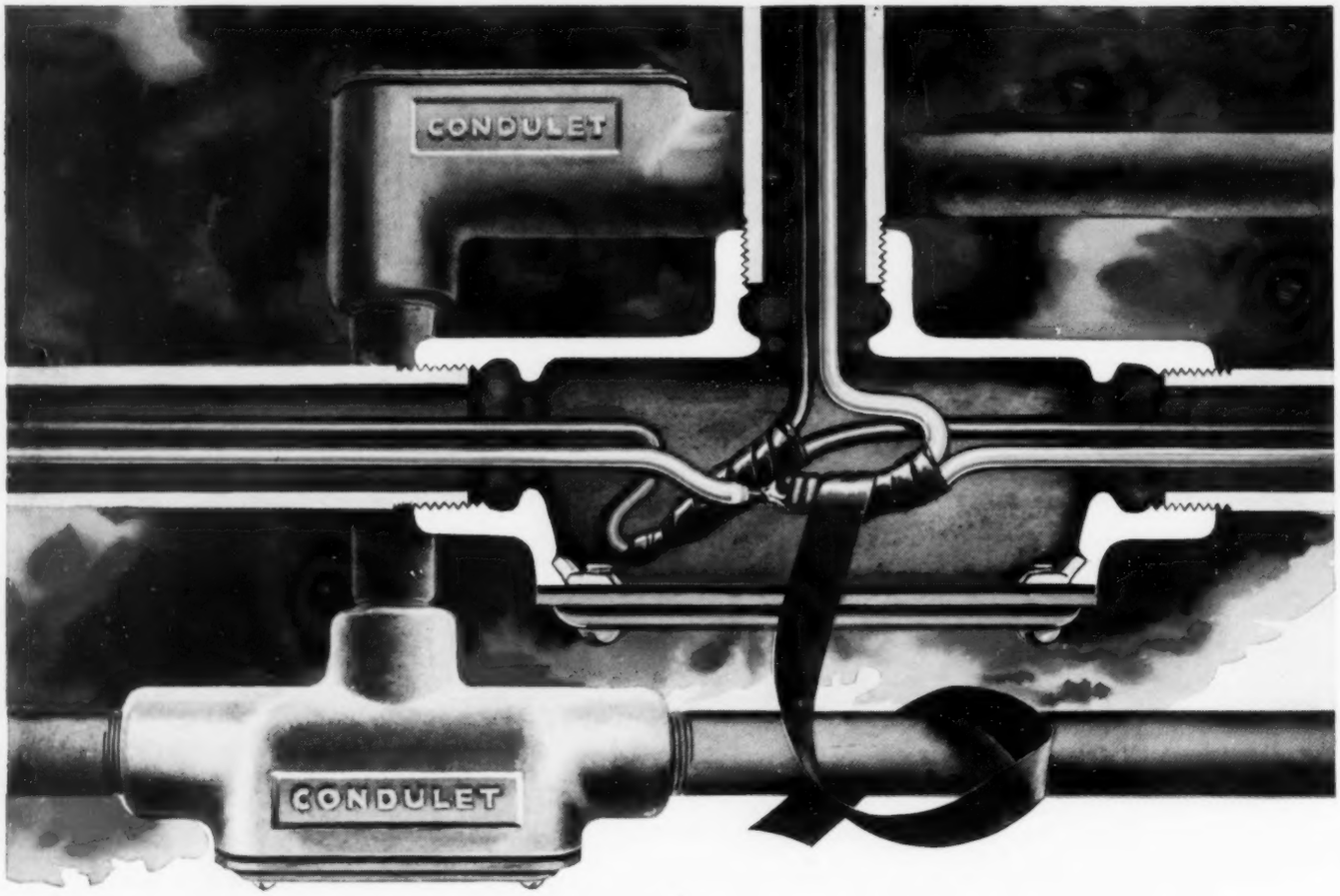
YOU CAN BE SURE...IF IT'S

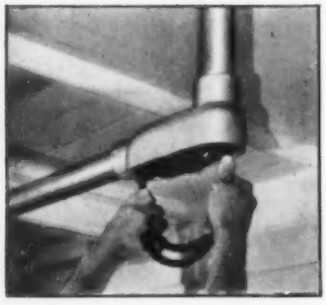
Westinghouse

These two new ore bridges can unload all size boats by means of an adjustable "apron" which can be raised high enough to allow the mast of any vessel to pass underneath. Dependable Westinghouse hold-and-close motors carry the load on this modern installation.

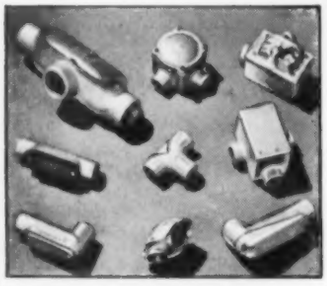


Rated at 187½ hp, 230 v, 460 rpm, this 616 Series mill motor gives the kind of outstanding performance to meet today's tougher, faster jobs. Westinghouse engineers are ready to work with you to give you the best motors and controls for your needs.





Condulets install easily. There's room inside to do a good wiring job. No sharp edges to scrape knuckles or cut into insulation. Once installed, wiring, Condulet and conduit are there to stay—yet wiring remains easily accessible for future alterations.



Used everywhere. There is a Condulet for every need, in every conceivable industry. Each one bears the marks of superior construction. Each is *made* by craftsmen to the standards craftsmen demand!

Why electrical engineers specify

"CONDULETS . . . OR APPROVED EQUAL"

Electrical engineers are called upon daily to make careful choices of materials for companies who depend upon their judgment for the quality of finished work.

"Condulets or approved equal" is the common notation on specification prints everywhere. It is used to indicate *the standard of performance* demanded by the electrical engineer.

A NATIONWIDE DISTRIBUTION exclusively through ELECTRICAL DISTRIBUTORS

More than 15,000 items of Condulet electrical equipment offer a broad choice of explosion-proof, dust-tight or conventional construction unparalleled for safety and dependability. In *any* plant, the chances are 2 to 1 you will find Condulet junctions, switches, conduit fittings, plugs and receptacles, panelboards, pushbutton stations, motor control centers, etc. Wherever you see the name Condulet, you see the standard by which maximum performance is measured.

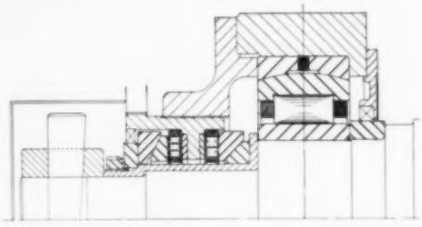
CROUSE-HINDS COMPANY

Main Office and Factory: Syracuse, N. Y.
Crouse-Hinds Company of Canada, Ltd.: Toronto, Ont.

There's an experienced product engineer ready to help you, at the nearest Crouse-Hinds office. Call: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington RESIDENT REPRESENTATIVES: Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport **Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.**

(*Continued from page 223*)

illustrated in conjunction with specially designed Rollway aligning radial roller bearing. Bearing's straight inner race is separable, with roller assembly self-contained in outer race. Outside diameter of double-flanged outer race is concave for



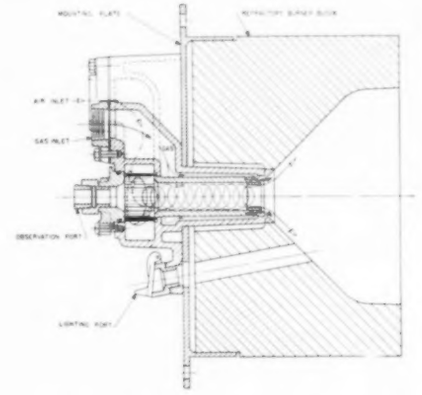
alignment with convex surface of aligning ring. Capacity of special MUC type radial bearing is 278,800 lb at 100 rpm.

Bearing capacity, size and design may be modified to customer specifications.

CONE GAS BURNER

▲ A new type of gas burner has been developed by Hauck Manufacturing Co., which provides a large radiant heat surface and high rate of heat transfer without flame impingement. This cone burner offers the advantages of economical operation and reduced maintenance in many heat processing applications.

The burner features high speed combustion and rapid penetration of the work by radiant heat, thereby reducing furnace size and con-



sequent economy in furnace cost and operation. With less furnace brickwork to heat up and less heat loss through furnace walls, there is considerable reduction in fuel input. Need for baffle walls or muffles to protect the work is often eliminated. Costly fire checks or mixers and back firing are also eliminated.

The burner utilizes any commercial fuel gas and provides mixing of air and gas at the stainless steel nozzle outlet. With short flame length and low forward velocity of combustion gases, heat can be distributed more uniformly and directed in required areas through roof walls or bottom of furnaces. Turndown ratio is more than 10 to 1, depending on air pressure.

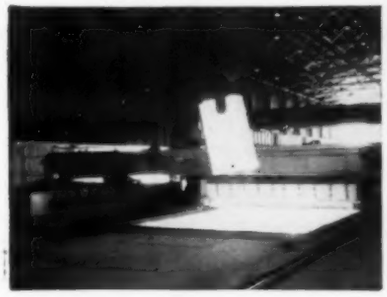
The burner is simple in design, with a minimum number of parts. Concentric air and gas nozzles have large area discharge ports, eliminating clogging. Metal burner parts do not extend into the heat of the radiant cone. All metal surfaces of the burner facing the heat are protected by the cool air and gas flowing over them, thereby avoiding oxidizing and deterioration of alloy metal or ceramic nozzles and their high replacement cost. The refractory burner block is made of super duty castable material. A lighting port is provided in the burner plate and refractory block.

The burner may be controlled manually, or by automatic pressure proportioning control or automatic mechanical control.

Open Hearth Furnaces—Photo Courtesy Jones & Laughlin Steel Corp.

Continuous Heating Furnaces—Photo Courtesy Crucible Steel Co.

Soaking Pit—Photo Courtesy United States Steel Corp.



Heat Treating Furnace—Photo Courtesy Taylor Forge & Pipe Works

Increase Production . . . Lower Production Costs with

LOFTUS Industrial FURNACES

For years Loftus Industrial Furnaces have been providing dependable, economical service to the steel industry. Their long life and efficient performance have been proved by time. The fact that they materially contribute to lower-cost operation and increased production is a matter of record.

Whatever your heating, melting or heat-treating requirements, it will pay you to take advantage of Loftus' long experience in furnace design and construction. Many of the world's leading companies have—and to their utmost satisfaction, as proved by the high percentage of repeat orders we get.

We'll be glad to send you full details and we will welcome an opportunity to quote on your requirements.

Designers and builders of industrial furnaces **LOFTUS** *Engineering Corporation*

610 Smithfield St., Pittsburgh 22, Pa.
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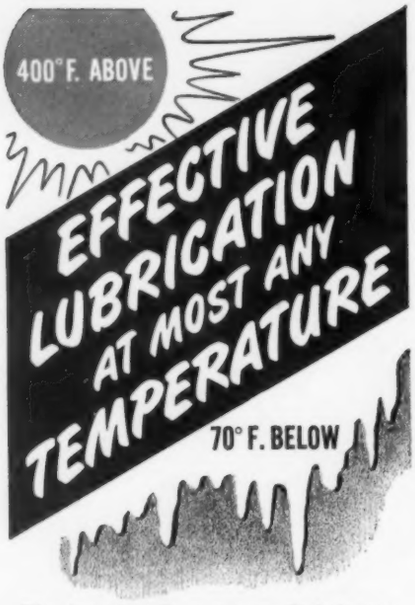


The fact that LUBRIPLATE Lubricants are able to meet extreme temperature conditions demonstrates the ability of these products to cope with the wide variations found in everyday industry. Besides this feature, LUBRIPLATE Lubricants possess attributes not found in conventional lubricants.

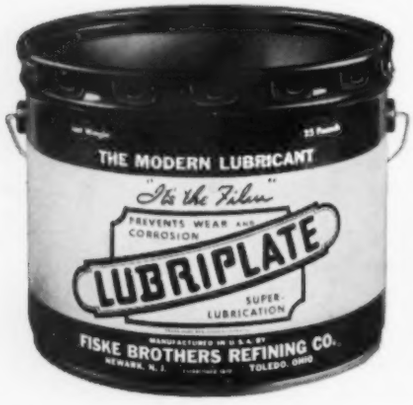
HIGH TEMPERATURES

LUBRIPLATE No. 930-AA.—Provides superior and protective lubrication for all types and sizes of machines operating at temperatures as high as 500°F. Possesses exceptionally high film strength and adhesiveness. Protects all metallic parts against rust and corrosion.

LOW TEMPERATURES

LOW-TEMP LUBRIPLATE—The outstanding multi-purpose grease type lubricant that will remain plastic at 70°F below Zero, yet has a Melting Point of 270°F. Resists water and acids—protects against rust and corrosion even from calcium chloride used on paved roads during winter months.

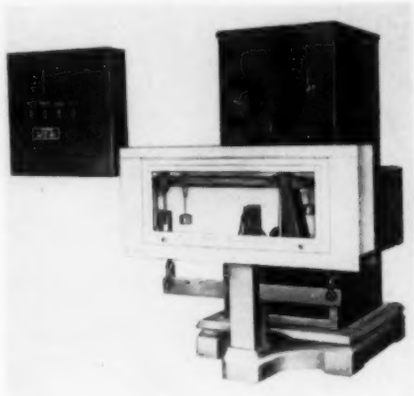
For nearest LUBRIPLATE distributor see Classified Telephone Directory. Write for free "LUBRIPLATE DATA BOOK"... a valuable treatise on lubrication. LUBRIPLATE DIVISION, Fiske Brothers Refining Company, Newark 5, N. J. or Toledo 5, Ohio.



WEIGH FEEDER MACHINE

▲ To provide a closer control of the introduction of bulk materials Syntron Co. has developed a new dry, chemical weigh feeder machine.

The machine will provide an extreme accuracy of feed (to within less than 1 per cent) of a pre-weighed batch of material at a pre-determined rate over a pre-deter-



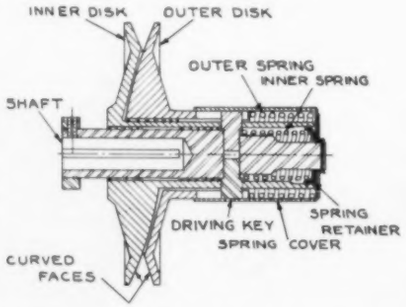
mined period of time. Material flow through the machine is electronically controlled. There is no mechanical linkage between scale and the feeder.

Audible or visual alarms can be furnished at the feeder, at the control box or elsewhere to signal the end of a cycle.

Three models are currently available with a range of output capacities of 1¼ to 25 lb per hour, 2½ to 50 lb per hour, and 5 to 100 lb per hour.

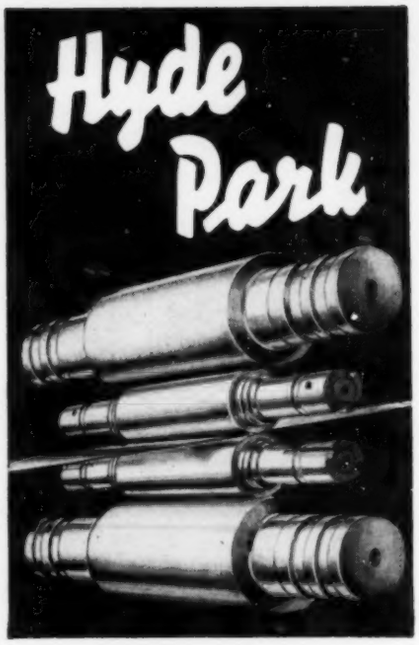
PULLEYS

▲ Variable speed pulleys with a speed ratio of 2½ to 1 have been developed by the Lovejoy Manufacturing Co. They are said to be practically maintenance-free, since



they have no intricate parts requiring periodic adjustment or complicated mechanisms needing frequent adjustment. Oil-impregnated bronze bushings eliminate lubrication.

These new units are easily in-



Red Circle Rolls for all Purposes

The Red Circle on the Roll is the Hyde Park mark of Quality. Hyde Park makes rolls for every type mill.

Chilled Rolls
Alloy Iron Rolls
Moly Rolls
Nickel Chilled Rolls
Grain Rolls
Cold Rolls
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Finer Finish, Longer Life
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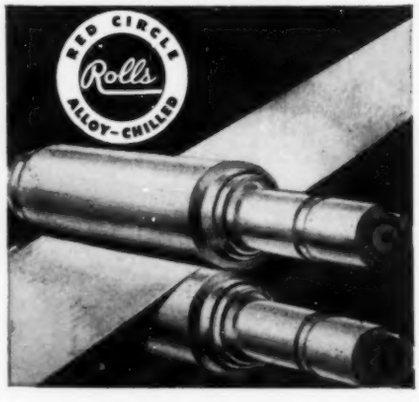
GREY IRON CASTINGS



Less down time...lower upkeep...

WITH

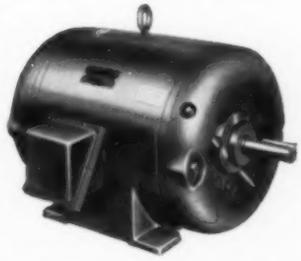
Wagner Protected Type Industrial Motors

Wagner protected type motors lower your maintenance costs . . . cut down time, because they are designed for use where operating conditions demand EXTRA protection—for bearings or windings, against corrosive vapors or abrasive dirt, in explosive atmospheres or exposed outdoor locations.

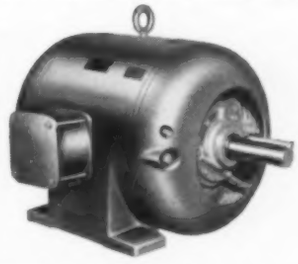
Each of these Wagner Motors will give completely dependable performance in its specific application—with a minimum of maintenance. All these motors can be relubricated, when necessary, for longer bearing life.

A Wagner field engineer, expert on motor applications, will be glad to help you choose the *right* motors for your specialized needs. Just call the nearest of our 32 branch offices, or write us for Bulletins on Wagner Industrial Motors.

TYPE EP—Ribbed frame fan-cooled. New NEMA Frames. 1 to 30 hp.



TYPE EP—Totally-enclosed fan-cooled. Corrosion-resistant frames. 40 to 250 hp.



TYPE JP—Fan-cooled . . . Explosion-proof. Cast iron frames. 40 to 250 hp.

TYPE DP—Drip-proof . . . corrosion-resistant. New NEMA Frames. 1 to 30 hp.

TYPE DP—Drip-proof. Cast iron frames. 40 to 125 hp.

TYPE RP—Drip-proof. Fabricated steel frames. 125 to 500 hp.

M57-8

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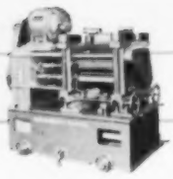
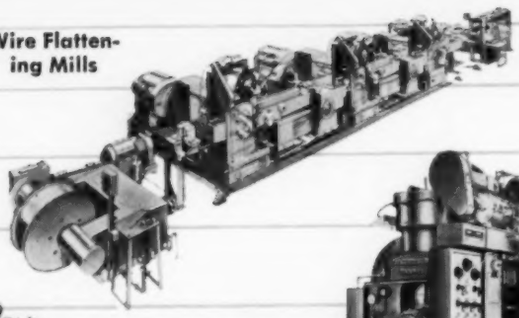
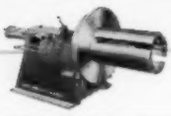


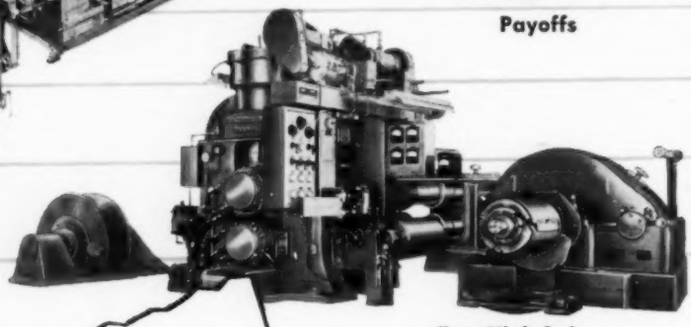
Coilers

Wire Flattening Mills

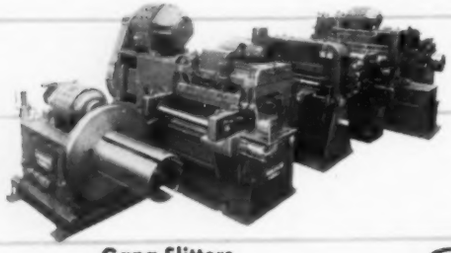




Payoffs



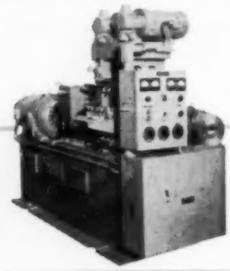
Two High Strip Rolling Mills



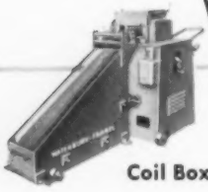
Gang Slitters

MEMO

Re Rolling Mill Modernization
Look Into Latest
Waterbury Farrel
Mill Machinery



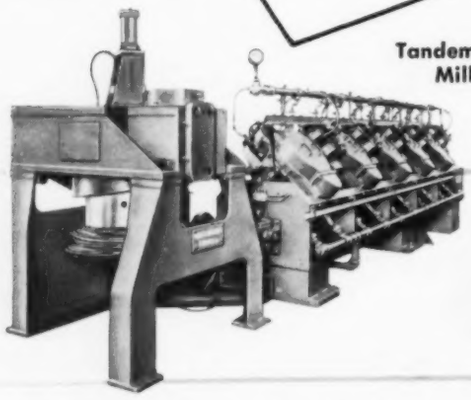
Four High Strip Rolling Mills

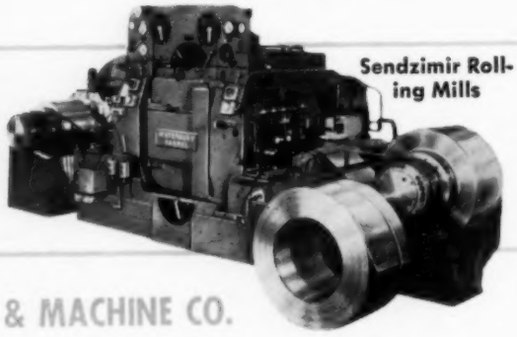


Coil Boxes

NEW, 48 PAGE MILL MACHINERY CATALOG. Gives a complete picture of the various types of mills and auxiliary equipment built by Waterbury Farrel. Send for your copy, today.

Tandem Rod Mills





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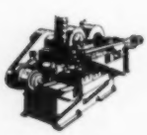
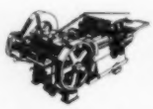
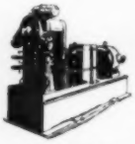


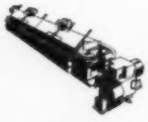
Bolt, Nut & Screw Machinery



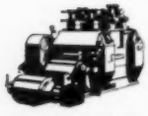
Power Presses



Rolling Mill Machinery



Wire Mill Equipment



Sendzimir Mills & Other Special Machinery

stalled on old or new equipment. They are especially recommended for simplified installation where speed changes are required to instantly compensate for variations in production schedules or differences in the ability of operators.

They use a standard B section V-belt. Model No. 175 is rated at ⅔ hp at 1150 rpm and 1 hp at 1750 rpm; No. 180 at 1 hp at 1150 rpm and 1½ hp at 1750 rpm Pitch diameter is 5.93 in. Length of bore is 2¾ in.

WELDER

▲ Designed primarily as a power source for the submerged arc process is a new 1000-amp a-c transformer welder announced by the General Electric Co.'s Welding Department.

With an operating range of 325 to 1000 amp, the new single-phase welder has motor-driven current

control. By means of a plug and receptacle, remote control of both welder output and primary contactor is available, in addition to the controls mounted permanently on the welder case.

With output open-circuit voltages of 85 to 100 v, the unit has power factor correction capacitors and operates on a reconnectable 230/460-v input. Built into the welder is a 2-kva control transformer, which can be used externally for operating of auxiliary equipment.

The unit is rated for continuous duty cycle at 1000 amp. All coils are protected by Class H Insulation, rated for 130 C temperature rise. A built-in current transformer, ratio 1500/5, is provided to facilitate measurement of welding current.

Book Reviews

"A New Look at the Nature of the Open-Hearth Process," by B. M. Larsen, Research Supervisor, United States Steel Corporation, Monroeville, Pennsylvania, has been published as a book by the National Open Hearth Steel Committee of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

Mr. Larsen has endeavored to give a unified analysis of the open hearth process in relation to the factors that control speed and fuel efficiency. Rate of heat flow in the bath, rate of carbon oxidation, and net heat requirement from fuel in relation to the amount of "air oxidation" from preheated or leakage air are treated quantitatively. Mechanisms of downward heat flow and of carbon oxidation in the bath indicate the probable effect of excess oxygen, available immediately above the bath surface, on increased absorption of oxygen from the gas phase.

The analysis indicates that fuel consumption might be reduced to about 2,000,000 Btu per ton with a charge-to-tap time of about five hours per heat if maximum advantage can be taken of the maintenance of an actively boiling bath with a supply of preheated air in sufficient excess above the needs of fuel combustion, made possible in a tight system with maximum regenerative efficiency.

Copies are available through the office of AIME, 29 West 39th Street, New York 18, N. Y. The price of the book is $3.00 with a special price of $2.00 being made for members of AIME.

"NEMA Standards Publication for Enclosed Switches, KS 1-1957," covers air-break switches which have their current-carrying parts enclosed in metal cases and which are manually operable by means of external handles and enclosed switches with or without provision for plug or cartridge-enclosed fuses are covered in this book. These switches may be heavy duty type HD, normal-duty type ND, or light-duty type LD. Information is given concerning safety requirements, temperature rise, enclosures, spacings, voltage and horsepower rating, tests and

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- Time of failure in life tests?
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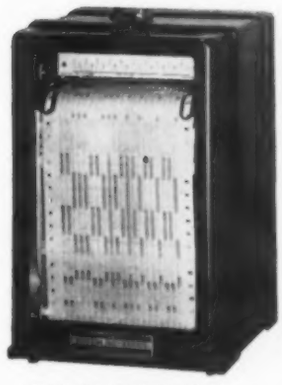

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marking. Copies may be obtained from the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N. Y., at $1.00 per copy.

"Industrial Lubrication Practice," by Paul D. Hobson, recently published by The Industrial Press, 93 Worth Street, New York 13, N. Y., contains 547 pages, 6¼ x 9¼ in., is cloth bound and sells for $8.00. This book provides basic information on lubrication practice and emphasizes practice. Lubrication theory is dealt with only in so far as is necessary to point out the reasons for techniques and phenomena described. The work includes an outline of lubrication principles and basic techniques. A chapter on plain bearings contains remarks and suggestions on bearing design to assist the designer in the choice of appropriate clearance from a table of standard fits, rather than to calculate the clearances according to strictly theoretical principles. Discussions of lubrication route and handling based principally on the author's experience are included. The book also has discussions on lubrication of specific machines and devices, chapters on hydraulic equipment, cutting fluids, and the preservation of machinery in transport and storage. The book ranges far from the strict bounds of lubrication to give an integrated picture of what may be going on in the mechanism being lubricated. An appendix and glossary are included as well as numerous tables and charts, line drawings and photographs.

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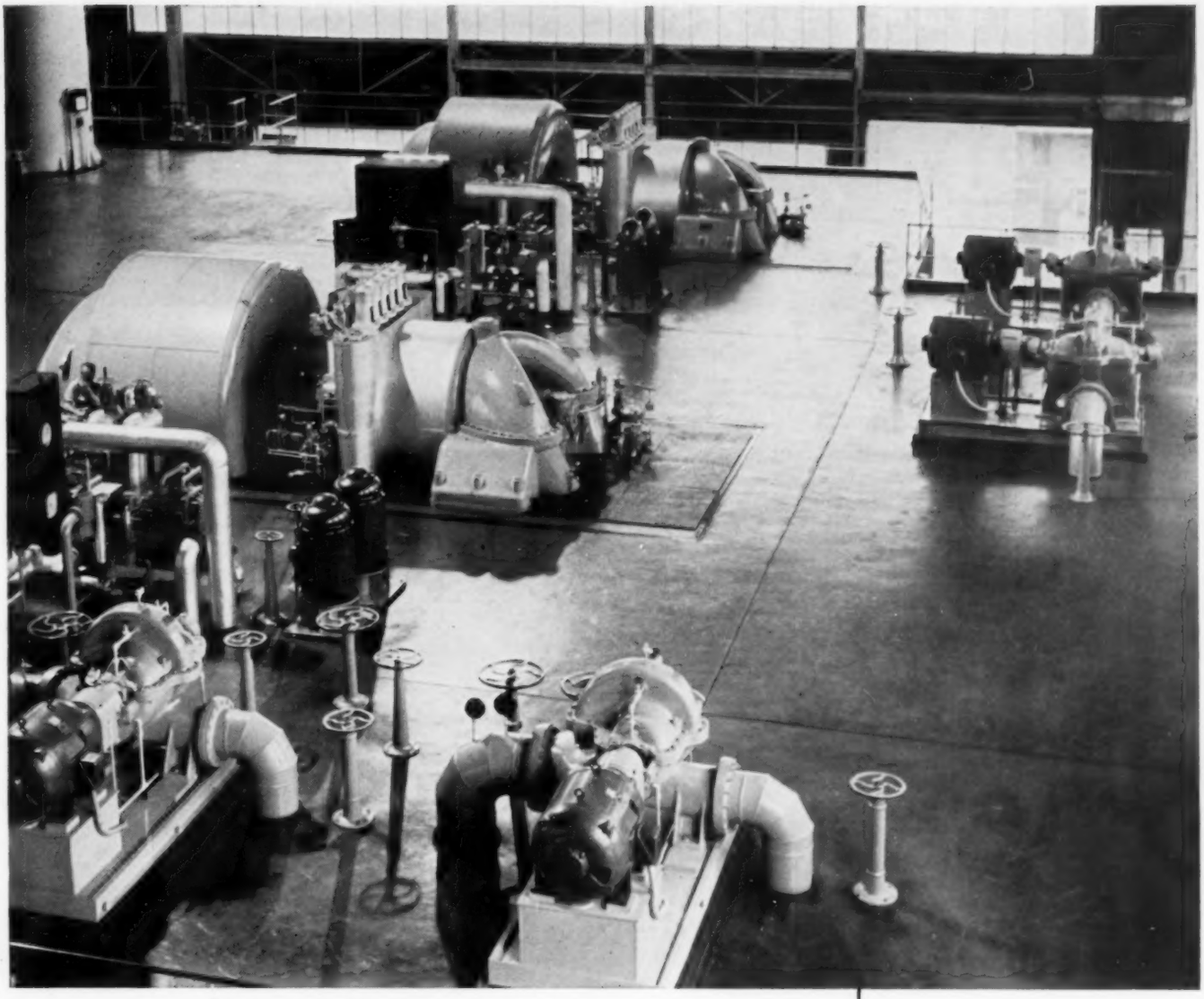
"NEMA Standards Publication for Panelboards, PB 1-1957," covers single panelboards, panel base assemblies or groups of panel units suitable for assembly in the form of single panelboards. These units are used in the distribution of electricity for light, heat and power at 600 volts and less, 1200-amp mains and less, and 600-amp branch circuits and less. The individual standards in this book cover types of panelboards, voltage and current ratings, dielectric and temperature rise tests nameplate information, current-carrying parts, bus connections, wiring terminals, grounding and insulation, fuses and application. Copies may be obtained from the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N. Y., at $1.00 per copy.

"ASTM Standards on Petroleum Products and Lubricants. (With Related Information)," 1096 pp, 6 x 9 in. cloth cover $7.50; paper cover $6.75 is a special compilation prepared by ASTM Committee D-2 which includes tentative and standard methods of test, specifications, definitions of terms and classifications of petroleum products and lubricants with related information, including the Report of Committee D-2 on petroleum products and lubricants, and proposed methods of test.

This book has been published annually since 1927; the present edition includes 180 standards, 48 of which are new or revised since the previous edition.

Copies may be obtained from the American Society for Testing

(*Please turn to page 240*)



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Installation	Years Operated	Volume SCFM	Pressure Drop Inches Water	Dust Loading Grains/SCF	
				Inlet	Outlet
A	4	78,000	30	3-19.0	.01-.04
B	3½	78,000	30	2-3	.02-.08
C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
H	½	90,000	29	—	.04

Installation C is in Illinois. Installation H is in Texas. All others are in Pennsylvania.

*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure.

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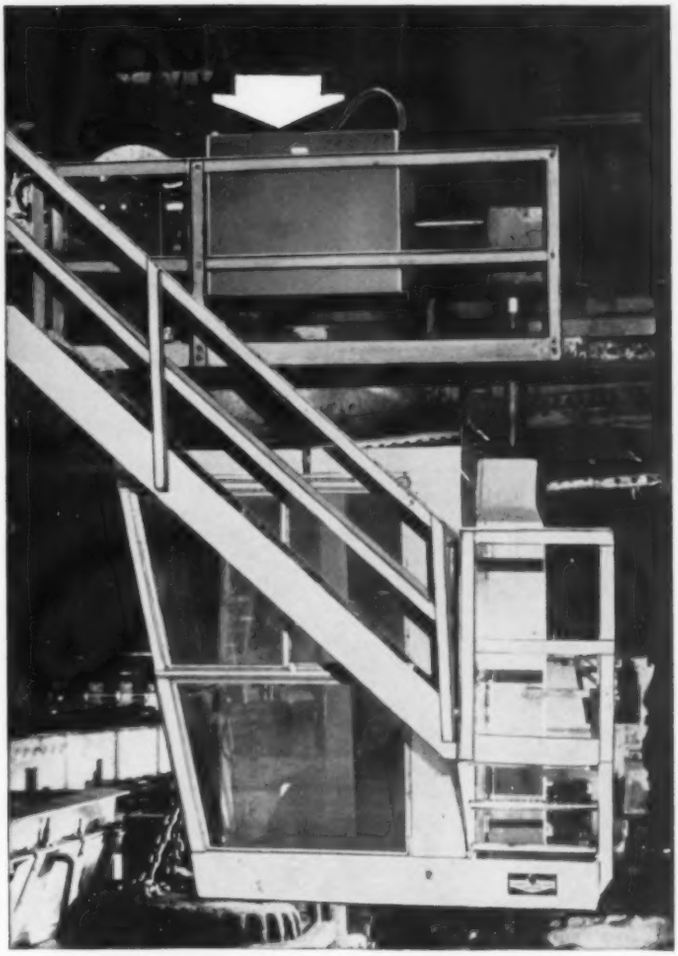

Lintern Aire-Rectifier (Model 513 AC-3S). Condenser, mounted on footwalk, is connected with cooling unit in cab by refrigerant lines of high pressure hydraulic hose.

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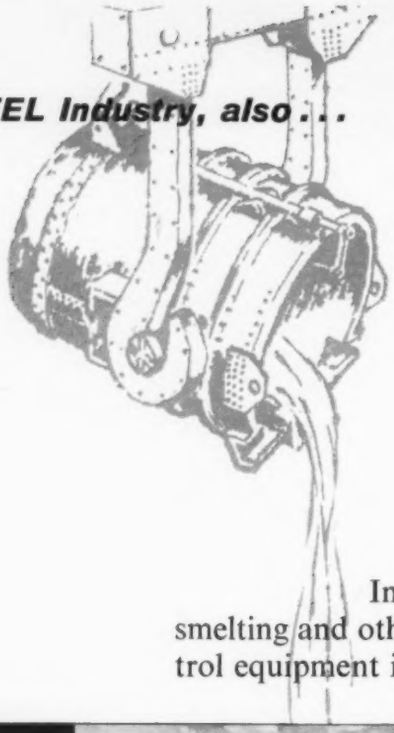

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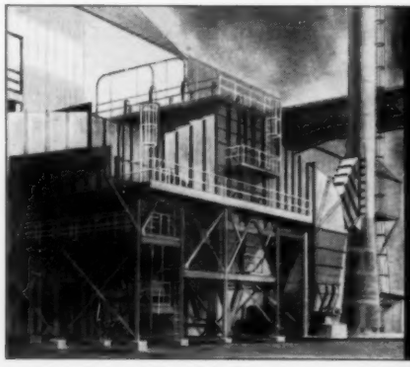
OPEN HEARTH FURNACES

At Kaiser Steel Company's Southern California Fontana operations, difficult dust and fume problems from hot metal open hearths were solved so successfully that similar Western Precipitation Cottrells are being installed on all the remaining open hearths!



SINTERING PLANTS

At a major East Coast steel plant, six CMP (Combination Multiclone-Precipitator) units have so effectively reduced the dust loading that costly maintenance or replacement of fan parts from abrasion has been virtually eliminated!

ELECTRIC FURNACES

At Jones & Laughlin's Otis Works in Ohio, Western Precipitation has been given the job of installing a complete "turn-key" dust control system on J. & L's electric furnaces. In addition to Cottrell Precipitators, Western Precipitation will install flame traps, flues, humidification towers, fans, stack and instrumentation—a complete "turn-key" installation!

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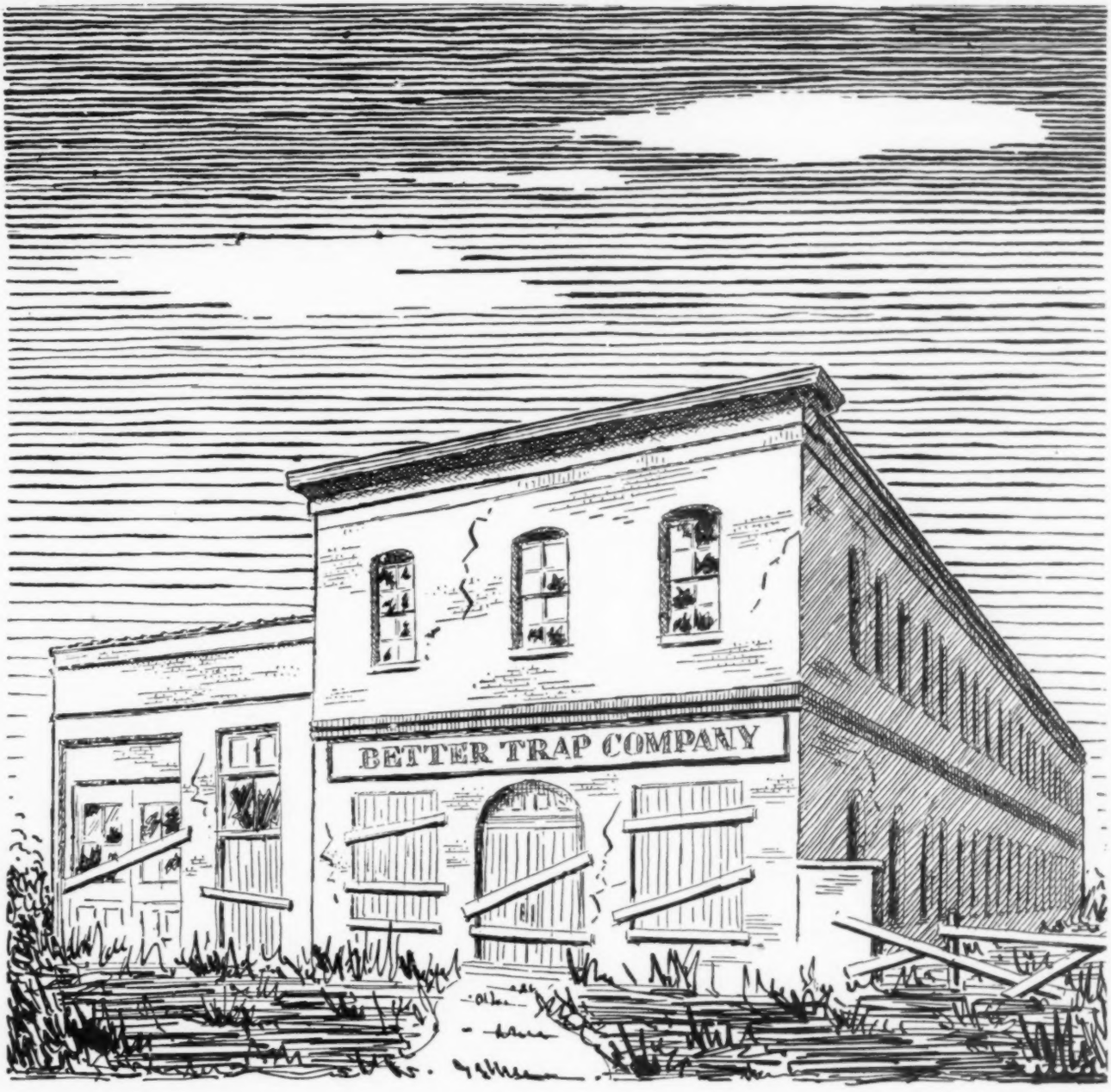

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BOOK REVIEWS

(*Continued from page 232*)

Materials, 1916 Race St., Philadelphia 3, Pa., at $7.50 each for the cloth covered edition or $6.75 each for paper covers.

"Report on Elevated-Temperature Properties of Wrought Medium-Carbon Alloy Steels" (ASTM Special Technical Publication 199) contains 127 pages, 8½ x 11 in., bound in heavy paper cover. It presents a graphical summary of the elevated-temperature strength data for medium-carbon alloy steels and includes summary curves for tensile strength; 0.2 per cent offset yield strength; per cent elongation and reduction in area; stresses for rupture in 100, 1000, 10,000, and 100,000 hr; and stresses for creep rates of 0.0001 and 0.00001 per cent per hr (one per cent in 10,000 and 100,000 hr). Data for 27 steels representing approximately a dozen alloy types are given. The report also contains data for a few miscellaneous low-carbon alloy steels. Copies are available from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., at $4.25 each.

"Symposium on Properties, Tests and Performance of Electrodeposited Metallic Coatings" (ASTM Special Technical Publication 197) contains 129 pages, 6 × 9 in., and is bound in heavy paper. The symposium contains the following papers: History of ASTM Committee B-8; The Corrosion Behavior and Protective Value of Copper-Nickel-Chromium and Nickel-Chromium Coatings on Steel; Evaluation of Methods Available for Measurement of Surface Luster of Electroplated Coatings; Recommended Practices for Cleaning Prior to Electroplating; A Comparison of the Corrosion Behavior and Protective Value of Electrodeposited Zinc and Cadmium Coatings on Steel; Evaluation of Phosphate Coating over Electrodeposited Zinc; Evaluation of Testing Methods for Supplemental Coatings; Atmospheric Exposure of Electroplated Lead Coatings on Steel; The Standard Salt-Spray Test—Is It a Valid Acceptance Test? Copies may be obtained from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., at $3.00 each.

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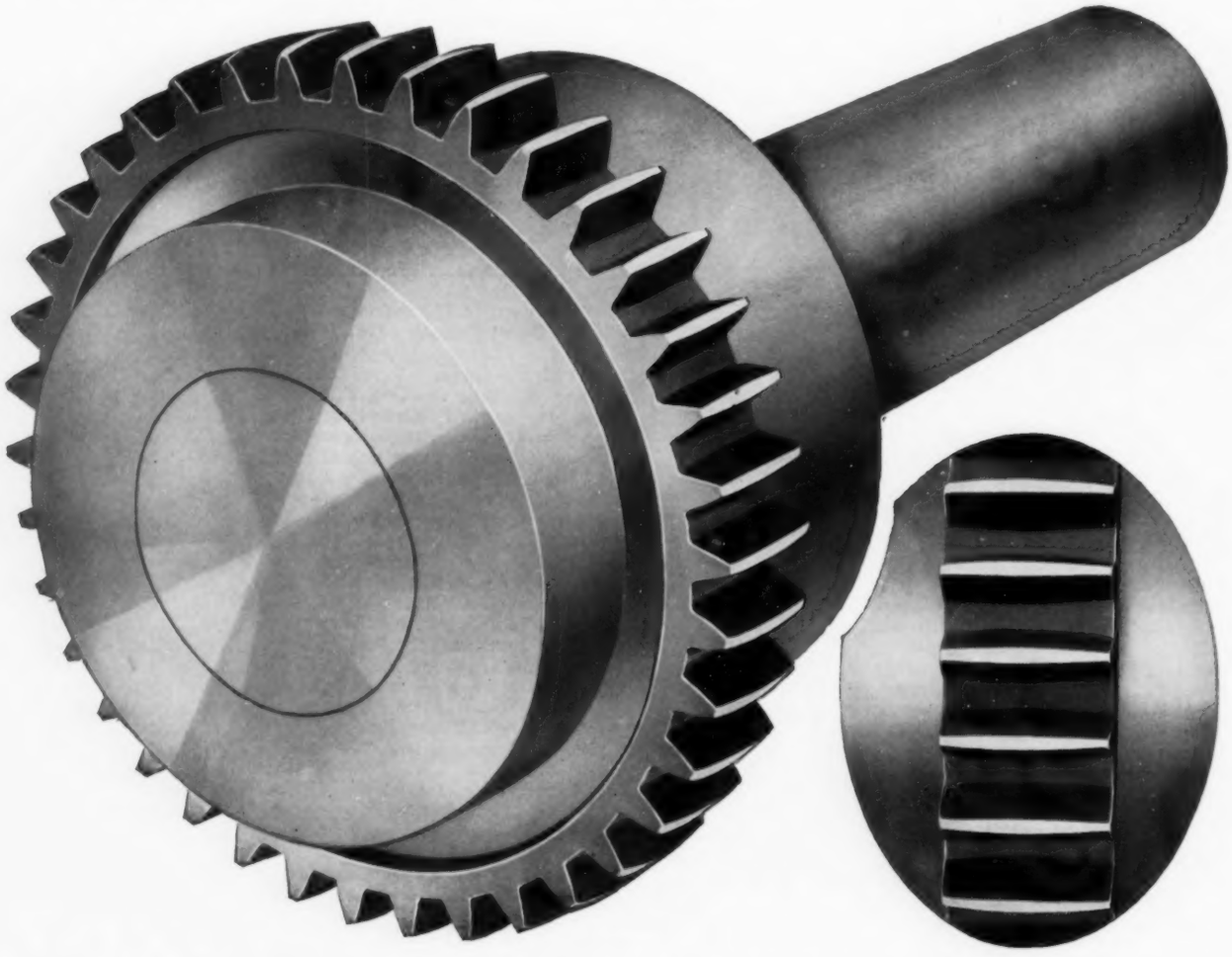

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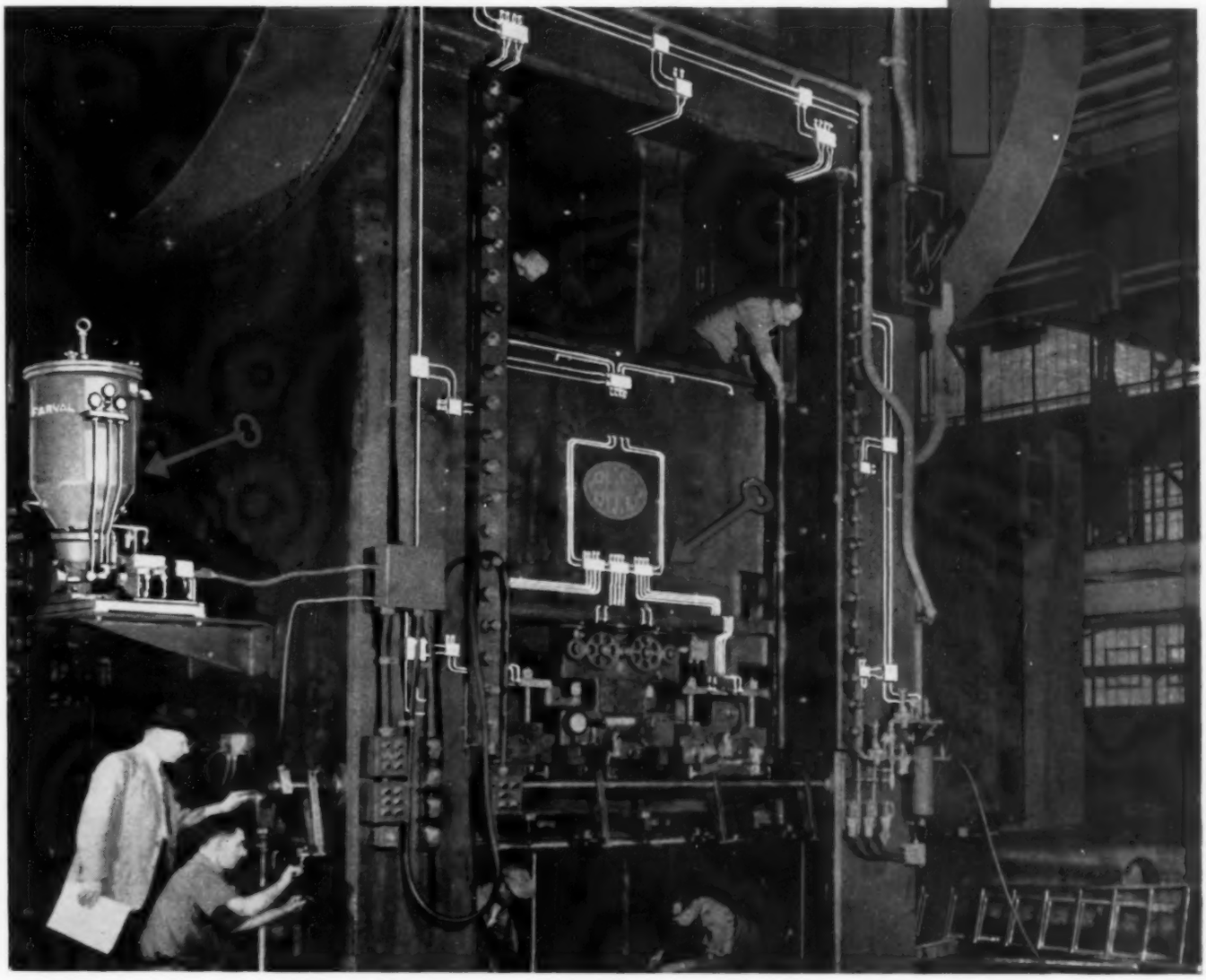

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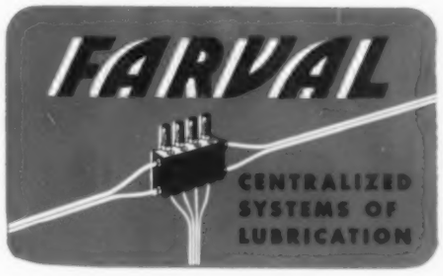

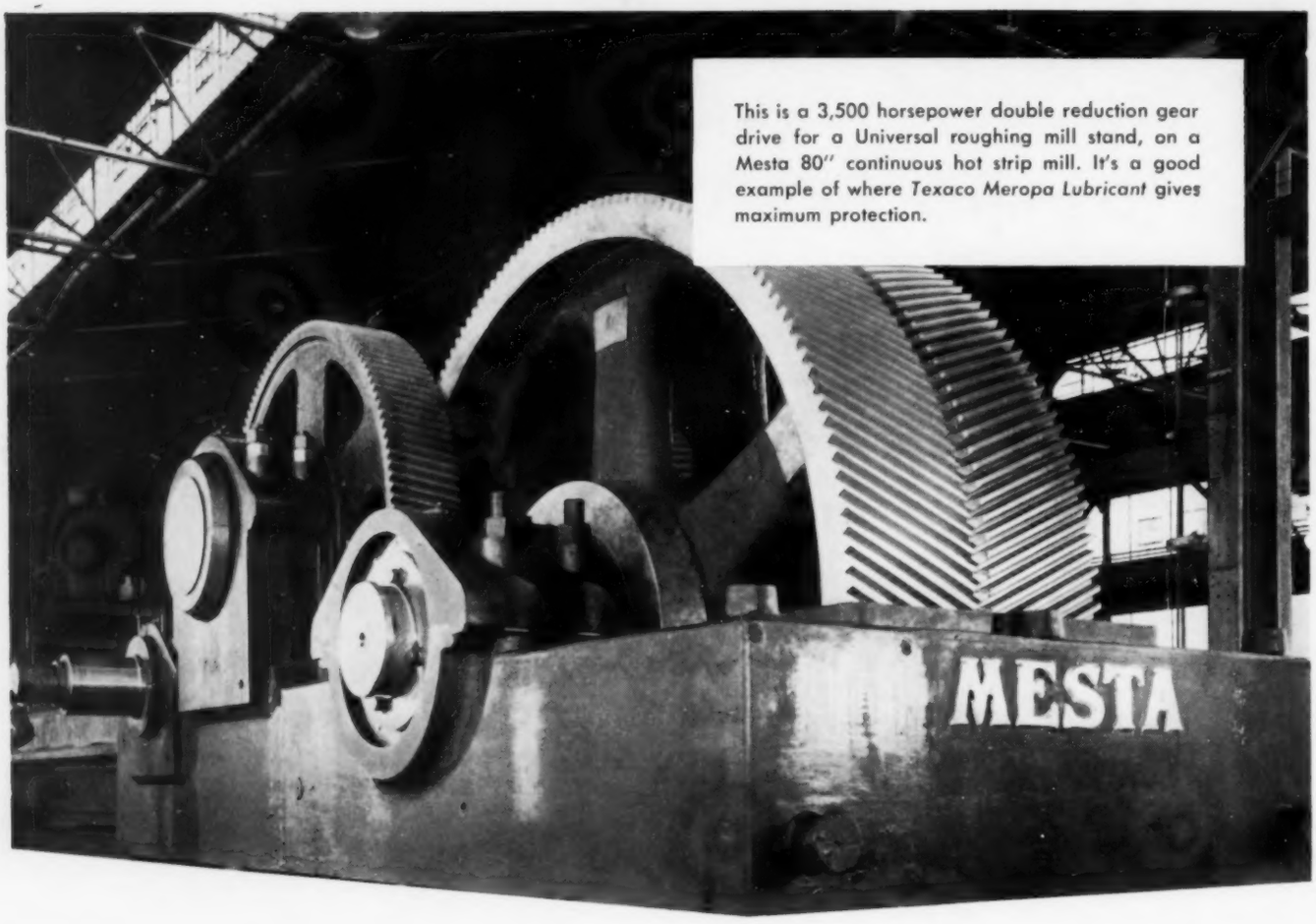

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